ENGINE 21

Index Page

General Description
Service Adjustments and Checks
Special Service Tool Recognition
Service and Repair Operations - Content 1
Service and Repair Operations 1
Technical Data 9

GENERAL DESCRIPTION

TRANSIT variants may be fitted with either a 2,4 litre Diesel engine or a range of petrol engines. The petrol engines are OHC/I-4 and OHV/I-4 engines. A 3,0 litre OHV/V6 engine is available as an S.V.O. (Special Vehicle Option)

OHC - overhead camshaft
OHV - overhead valves
I-4 - in-line engine - 4 cylinders

This section deals with all petrol engines except the 3,0 litre V6 engine.

The 3,0 litre V6 engine is described in Section 21C and the Diesel engine is dealt with in Section 21B of this manual.

For simplification, the engines are only identified by a letter in the following description, as is the practice in other Workshop Manuals.

The chart below indicates which engines are fitted.

Engine Summary

Cubic capacity in litres	Compression ratio	Engine type	kW (HP)	Engine code on block	Identification in workshop manual
1,6*	LC	OHV/I-4	47 (63)	LIC	A
1,6	LC	OHC/I-4	48 (65)	LAT	B
2,0 Economy	LC	OHC/I-4	43 (58)	NUT	B
2,0	LC	OHC/I-4	57 (78)	NAT	B
2,0 (with auto. transmission)	LC	OHC/I-4	55 (75)	NAV	B
2,0 (variants with HD version)	LC	OHC/I-4	57 (78)	NAW	B
2,0 (with HD cooling)	LC	OHC/I-4	57 (78)	NAW	B
3,0	LC	OHV/V6	74 (100)	HX	F
2,4	Diesel	OHV/I-4	46 (62)	4AA	G

LC = low compression
* = Great Britain only

The 'A' engine, Fig. 1, is a water-cooled, 4-cylinder, 4-stroke, in-line, petrol engine. The overhead valves are operated by tappets, pushrods and rocker arms. The camshaft is located to one side of the block and is driven by a roller chain. The drive gear for distributor and oil pump is located behind the second cam, the eccentric driving the fuel pump is located between the sixth and seventh cams. The cylinder head is of crossflow design, the combustion chambers extend into a bowl in the crown of the pistons.

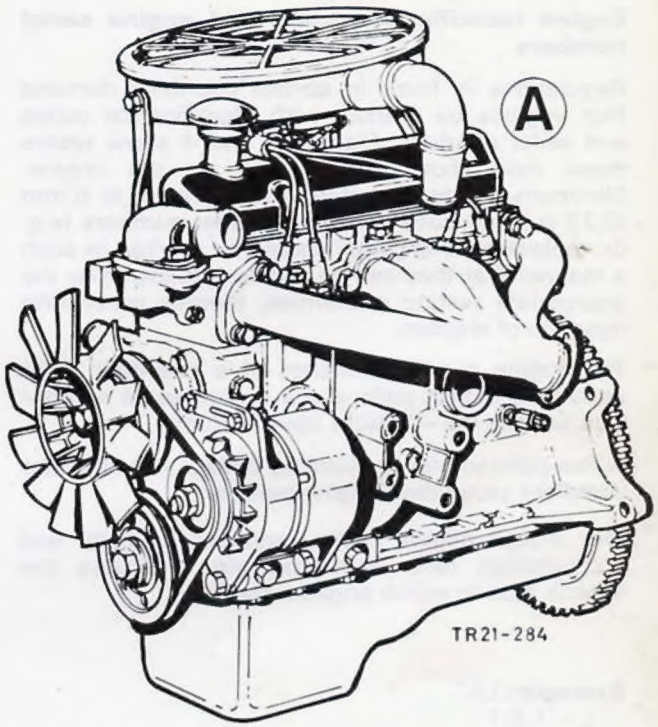


Fig. 1. 'A' engine

The 'B' engine, Fig. 2, is a water-cooled 4-cylinder 4-stroke in-line petrol engine. The overhead valves are arranged in the cylinder head in slight V-formation and directly actuated via cam followers. The camshaft is located centrally above the cam followers in the cylinder head and is driven from the crankshaft via a toothed belt which also drives the auxiliary shaft. The auxiliary shaft drives distributor, oil and fuel pump. The cylinder head in which the combustion chambers are located is of crossflow design.

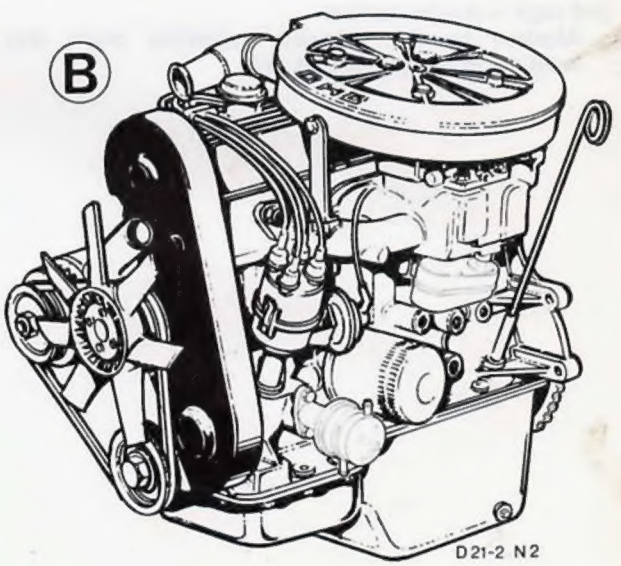


Fig. 2. 'B' engine

GENERAL DESCRIPTION (cont'd)

Engine identification code and engine serial numbers

Regulations in force in certain countries demand that engines be marked with identification codes and serial numbers. Figures 3 and 4 show where these data should be marked on the engine. Minimum height of letters and numbers is 6 mm (0,25 in.) and both codes and serial numbers (e.g. on replacement engines) should be marked in such a manner that they can be clearly recognized by the appropriate testing authorities, thereby preventing rejection of engines.

The engine number consists of a two-digit build year/build month code and a 5-digit serial number (see Section 00 – Vehicle Identification).

A five-pointed star is stamped before and after the complete seven digit engine number.

The 3-digit engine code comprises capacity and compression ratio data and also indicates the vehicle type to which engines are fitted.

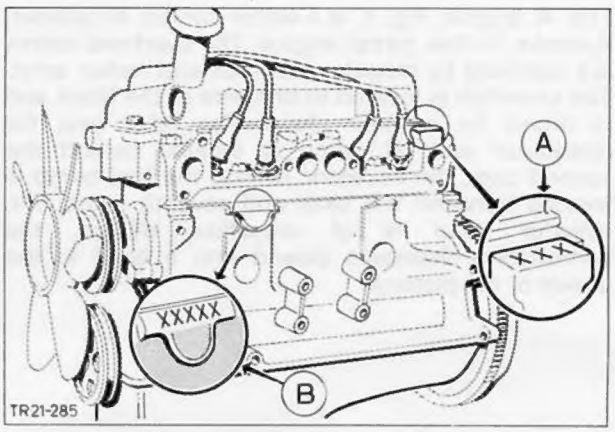


Fig. 3. 'A' engine
A – Engine code
B – Engine number

Example: LAT
L = 1,6:1
A = low compression
T = Transit

Engine code definition

1st digit = engine capacity
L = 1,6:1
N = 2,0:1

2nd digit = compression ratio
A = LC
U = LC
1 = LC

3rd digit = model variant
Marked by the relevant assembly plant and relating to model variant only.

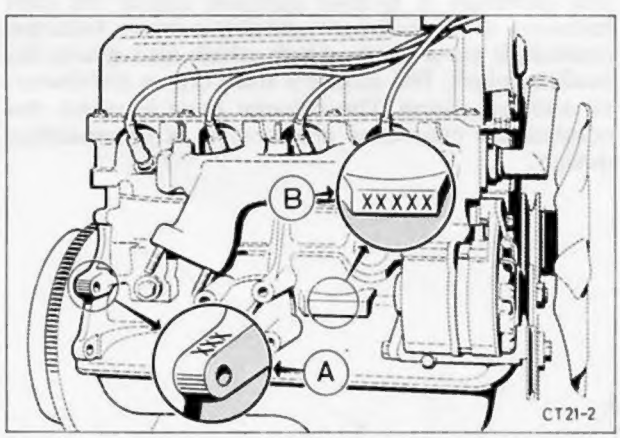


Fig. 4. 'B' engine
A – Engine code
B – Engine number

SERVICE ADJUSTMENTS AND CHECKS

To check the engine oil level the vehicle should stand on level ground and the engine should be at normal operating temperature. Before carrying out the check, wait a short time to allow all oil to drain back into the sump.

Withdraw the dipstick, wipe it clean with a rag, replace and withdraw it again. The oil on the dipstick indicates the oil level in the sump, it should lie between the two marks, Fig. 5 and 6. The quantity of oil required to top up from the bottom mark to the top mark is 0,75 to 1,0 litre (1,3 to 1,75 pints) approximately, depending on the engine capacity.

If necessary, top up through the filler neck with engine oil to FORD specification.

Topping up is not necessary until the oil level drops to the bottom mark. Do not allow the oil level to drop any further. Never top up to above the top mark since the excess oil is wasted, i.e. the oil consumption is increased.

The engine oil should be changed and the oil filter renewed at least every 10 000 km (6000 miles). If conditions of use are severe, e.g. short trips, frequent starts from cold, dusty roads etc, the oil should be changed and the oil filter renewed at shorter intervals.

If the specified engine oil is not used the inevitable consequence will be excessive wear or damage to the engine. The oil film becomes discontinuous and engine components under high thermal stresses are subjected to increased wear. Residues collect in the sump and block the oil passages. In addition, poor quality oil does not protect against corrosion so that rust forms on the cylinder walls. After a relatively short time the efficiency of the engine will decrease and there will be increased fuel and oil consumption.

Always use a branded oil complying with FORD specification (Refer to Technical Data).

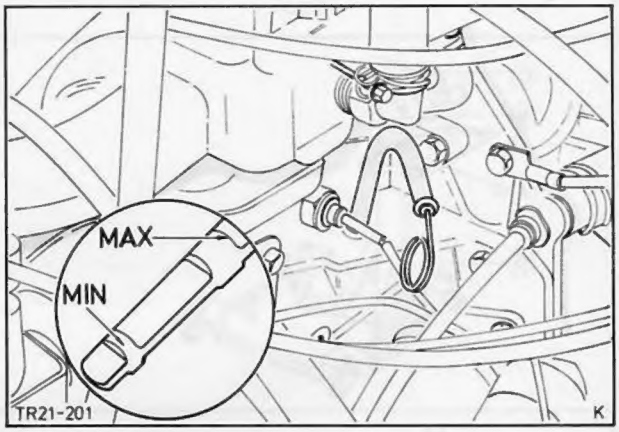


Fig. 5. Engine oil level check – 'B' engine

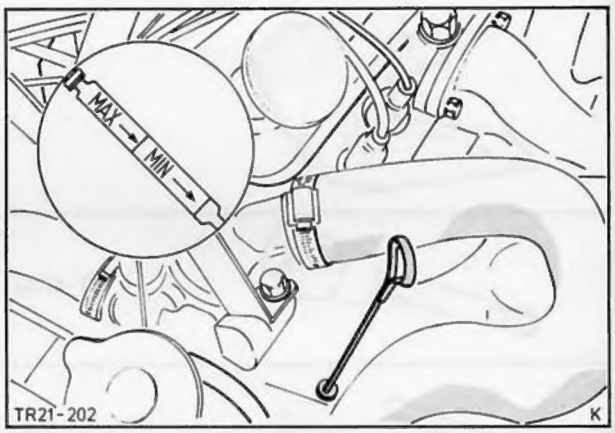
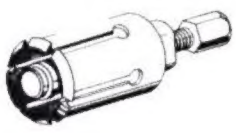
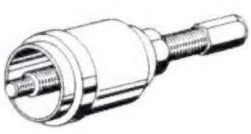
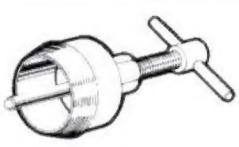
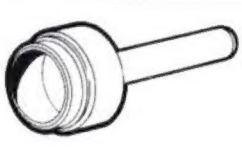
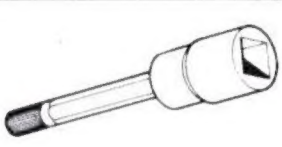
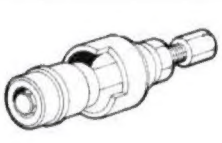
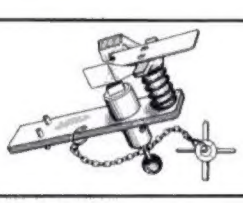
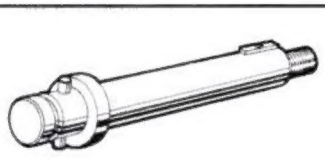
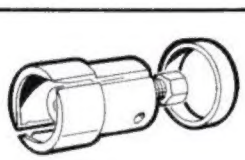
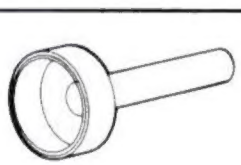
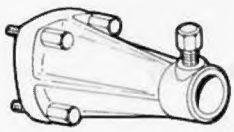
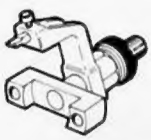


Fig. 6. Engine oil level check – 'A' engine

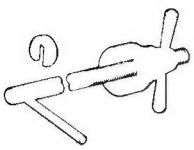
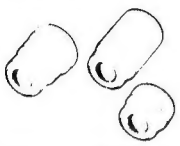
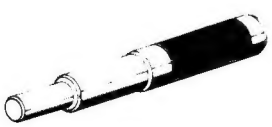
SPECIAL SERVICE TOOL RECOGNITION (cont'd)

Tool		Tool Name
	21–008–A	Camshaft, crankshaft and auxiliary shaft oil seal remover
	21–009–A	Camshaft, crankshaft and auxiliary shaft oil seal replacer
	21–010	Crankshaft rear oil seal remover
	21–011–A	Crankshaft rear oil seal replacer
	21–012	Oil pump bolt and drive belt tensioner socket
	21–013–A	Camshaft bearing remover/installer
	21–014	Piston pin installer
	21–023	Universal spindle
	21–028	Crankshaft gear remover
	21–030	Crankshaft rear oil seal installer

SPECIAL SERVICE TOOL RECOGNITION (cont'd)

Tool	Tool Name
 21–031	Engine mounting bracket
21–034	Cylinder head bolt wrench
21–036	Flywheel bearing remover
21–042	Valve guide reamer
21–044	Flywheel bearing replacer and clutch disc aligner
21–046	Crankshaft front oil seal installer
 21–047	Oil seal retainer cutter (seal carrier)
21–051	Multi-purpose oil seal remover
21–056	Valve spring compressor
21–057	Valve retainer

SPECIAL SERVICE TOOL RECOGNITION (cont'd)

Tool	Tool Name
 21–062	Camshaft bush remover/installer (main tool)
 21–062–01	Camshaft bush remover/installer (adaptor for 21–062)
21–068 (G1–6000 and G2–6000)	Engine lifting bracket
21–071 (GC–6035–B)	Valve guide reamer 0,2 mm oversize
21–072 (GC–6085–C)	Valve guide reamer 0,4 mm oversize
21–073	Valve guide reamer – 0,6 mm oversize
21–074	Valve guide reamer – 0,8 mm oversize
 21–080	Flywheel bearing installer and clutch disc aligner

SPECIAL SERVICE TOOL RECOGNITION (cont'd)

The modification shown in Fig. 6a must be made to the existing valve spring compressor 21–005 to facilitate work on TRANSIT vehicles.

This modified tool can still be used on all other vehicles.

The modified tool has been numbered 21–005–A by the manufacturer.

So when re-ordering, the valve spring compressor is now only available with the new tool number.

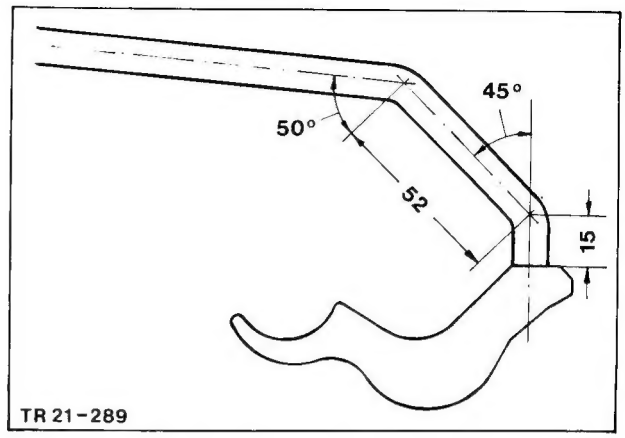


Fig. 6a. Modification to valve spring compressor 21–005

SERVICE AND REPAIR OPERATIONS CONTENT

ENGINE		Described for engine		Contained in operation	Also applicable to following models				
		A	B		Fiesta	Escort	Taun/Cort.	Capri	Granada
21 111	Engine – check compressions	X	X		X	X	X	X	X
21 112	Oil pressure – check	X	X		X	X	X	X	X
21 134	Engine – remove and install	X	X		X	X	X	X	X
21 134 8	Engine assembly – dismantle and reassemble (engine removed)	X	X		X —	X —	X X	X X	— X
21 154	Sump – remove and install	X	X		—	—	—	—	—
21 163	Cylinder head – remove and install	X	X		X —	X —	X X	X X	— X
21 165 5	Cylinder head – replace (cylinder head removed)	X	X		X —	X —	X X	X X	— X
21 213	Valve clearances – adjust	X	X		X —	X —	X X	X X	— X

SERVICE AND REPAIR OPERATIONS CONTENT (cont'd)

ENGINE		Described for engine		Contained in operation	Also applicable to certain variants in the following model ranges				
		A	B		Fiesta	Escort	Taun/Cort.	Capri	Granada
21 215 4	Valve – remove and install (one) (cylinder head removed)	X	X		X	X	X	X	X
21 231 9	Valve seat – cut (one) (valve removed)	—	—	21 233 9	X	X	X	X	X
21 233 9	Valve guide – ream (one) (valve removed)	X	X		X	X	X	X	X
21 238	Seals – valve stem – replace (all)	X			X	X	X	X	—
			X		—	—	X	X	X
21 255 9	Rocker shaft – overhaul (rocker shaft removed)	X			X	X	X	X	—
21 288	Seal – camshaft – replace		X		—	—	X	X	X
21 304	Timing belt – replace		—	21 467 'B'	—	—	X	X	X
21 467	Seal – crankshaft front – replace	X			X	X	X	X	—
			X		—	—	X	X	X
21 468 4	Seal – crankshaft rear – replace (engine or gearbox removed)	X	X		X	X	X	X	X
21 469 4	Oil carrier – crankshaft rear – cut out (flywheel removed)	X			X	X	X	X	—
21 505 5	Piston – replace (piston and connecting rod removed)	X			X	X	X	X	—
			X		—	—	X	X	X
21 553	Auxiliary shaft – remove and install		X		—	—	X	X	X
21 556	Seal – auxiliary shaft – replace		—	21 553 'B'	—	—	X	X	X
21 584 5	Ring gear – flywheel – replace (flywheel removed)	X	X		X	X	X	X	X

21 111 ENGINE – CHECK COMPRESSION

Testing Appliance Required:

Standard compression tester

The varying compression tester designs and fluctuating starter motor speed mean that for the most part one can only check for even compression in the individual cylinders. Measurement of the actual compression is dependant on several factors and requires certain pre-conditions. The engine should be at normal operating temperature and valve clearances must be set correctly.

NOTE: it is important also to disconnect the coil L.T. leads when removing H.T. leads. Failure to do this could constitute a fire risk or result in H.T. electrical shock.

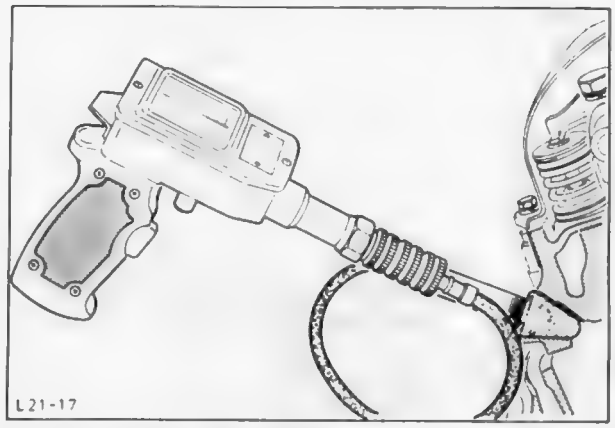


Fig. 7. Compression tester

To Check

1. Disconnect HT leads and remove spark plugs. Insert graph paper into tester. Press tester with its rubber seal tightly into spark plug orifice, Fig. 7. With throttle fully open, crank engine with starter motor until pointer of tester rises no further.

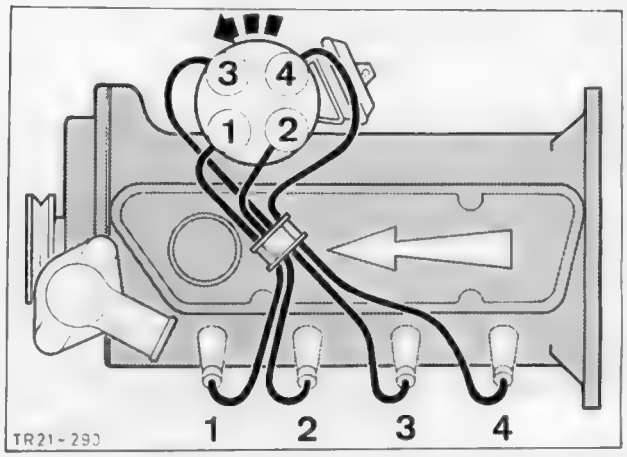


Fig. 8. HT leads (Firing order) 'A' engine

2. Vent tester, adjust graph paper for next cylinder and repeat procedure described in sub-operation 1 for each of other cylinders.

   Replace spark plugs and reconnect HT leads, Figs. 8 and 9.

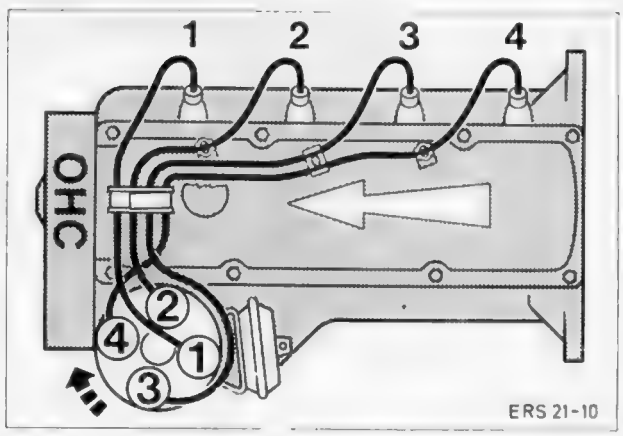


Fig. 9. HT leads (Firing order) 'B' engine

21 112 OIL PRESSURE – CHECK

Testing Appliance Required:

Oil pressure test gauge.

Oil pressure depends on various factors (engine speed, oil temperature, rotor clearance etc.). Pressure should always be checked at an oil temperature of 350 °K (80 °C) (175 °F). The oil pressure at idle should be at least 1 bar (1 kgf/cm²) (14 lbf/in²). Maximum pressure at speeds above 2000 rev/min should, however, not exceed 5 Bar (5 kgf/cm²) (71 lbf/in²).

If the pressures are outside these limits first eliminate the oil pump, Fig. 10, as the source of the fault. The following faults can occur, e.g:

Pressure too high at speeds over 2000 rev/min;

Failure of relief valve to open because of fouling;

Pressure too low at all engine speeds: Low oil level, clogged intake strainer, intake pipe broken or loose, oil pump worn etc;

Pressure too low at low engine speeds;

Relief valve jammed in the open position due to dirt.

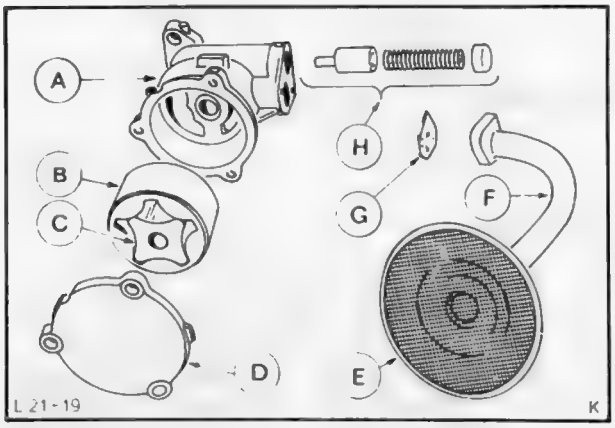


Fig. 10. Dismantled oil pump 'B' engine
A – Oil pump body
B – Outer rotor
C – Inner rotor
D – Cover
E – Strainer
F – Pick-up pipe
G – Gasket
H – Relief valve

To measure the oil pressure

1. Remove oil pressure switch lead connector and remove oil pressure switch, Fig. 11. In case of pressure gauge, remove pressure line and connector.

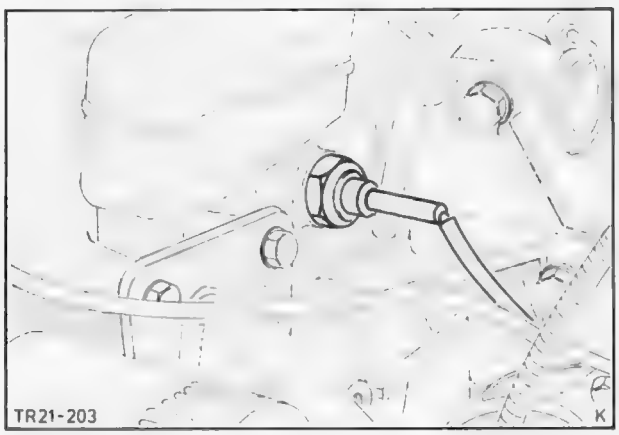


Fig. 11. Oil pressure switch ('B' engine)

2. Connect test pressure gauge to engine block, using adaptors if necessary, Fig. 12
3. Start engine and check oil pressure at idling speed and at over 2000 rev/min.
4. Remove test pressure gauge and adaptor. Replace oil pressure switch or pressure gauge and connect up.

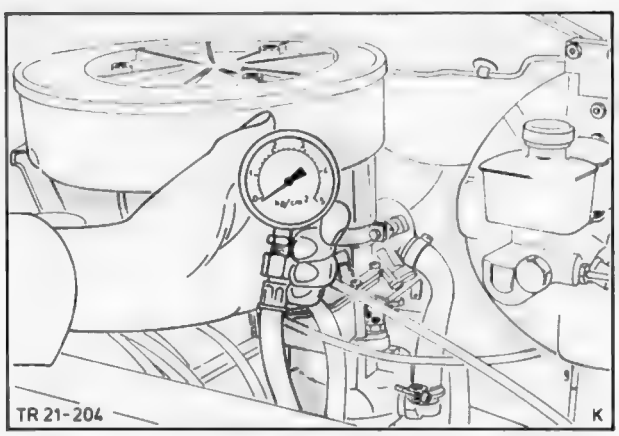


Fig. 12. Connect pressure gauge

21 134 ENGINE – REMOVE AND INSTALL

Special Service Tools Required:

Engine lifing bracket Engine lifting eyes	21–068

To Remove

1. Disconnect earth lead from battery.
2. Disconnect screen washer hose from T-piece and retaining clip, remove hood (4 bolts).
3. Drain coolant into a receptacle by detaching lower radiator hose from water pump, Fig. 13, and disconnect top hose from thermostat housing and remove.
4. On the 'A' engine, unbolt fairing (4 bolts) and remove complete with radiator.

Sub Operations 5 and 6 only apply to the 'B' engine.

5. Disconnect hood cable from catch spring and unbolt from radiator grill panel. Remove right and left-hand headlamp units (2 bolts each).
6. Detach bumper side pieces from clips and unbolt bumper with brackets (2 nuts).

   Remove radiator grille complete with the radiator, Fig. 14 (19 bolts).
7. On the 'A' engine, detach air cleaner from brackets.

   On the 'B' engine, detach air cleaner with bracket.

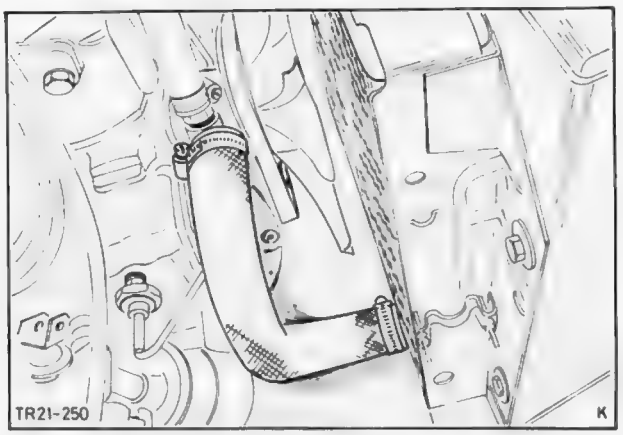


Fig. 13. Detach radiator hose from water pump ('A' engine)

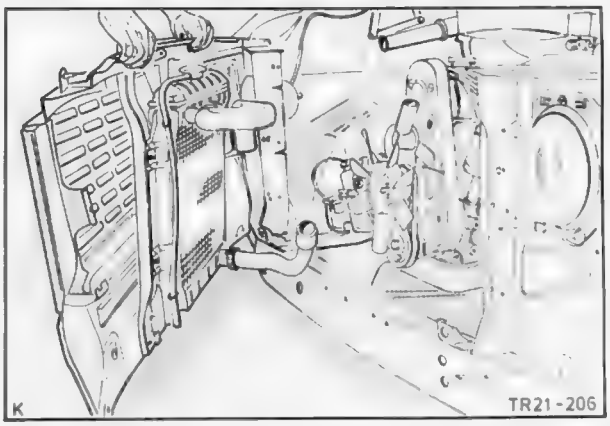


Fig. 14. Remove radiator grille panel with radiator (only necessary on 'B' engine)

8. Remove heater hoses from automatic choke/inlet manifold and water pump, Fig. 15.

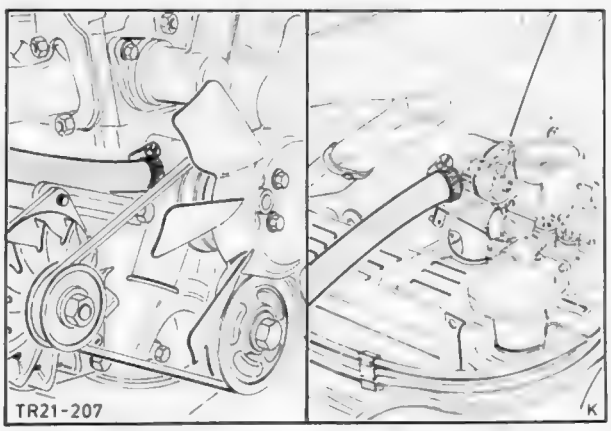


Fig. 15. Detach heater hoses ('B' engine)

9. Disconnect throttle cable from throttle linkage. Unbolt retaining bracket from inlet manifold (2 bolts) and detach with accelerator cable. Disconnect choke cable, when fitted.
10. Detach fuel line from petrol pump, Fig. 16. Detach brake servo vacuum hose from inlet manifold.

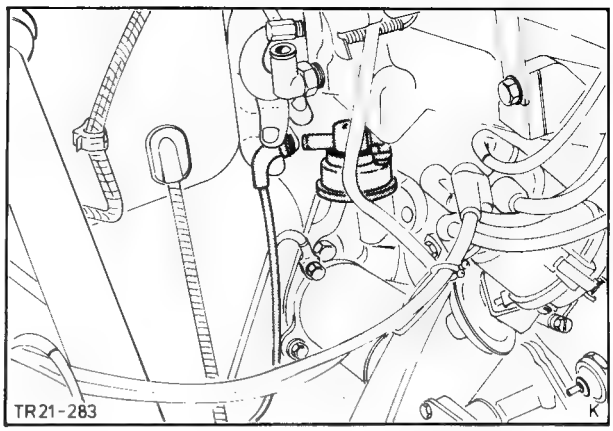


Fig. 16. Remove fuel line from petrol pump ('A' engine)

11. Disconnect leads from oil pressure switch, alternator, temperature gauge sender unit, coil and idling cut-off valve.
12. Disconnect starter leads and remove starter motor (3 bolts), unbolt exhaust pipe from exhaust manifold (2 bolts), Fig. 17.

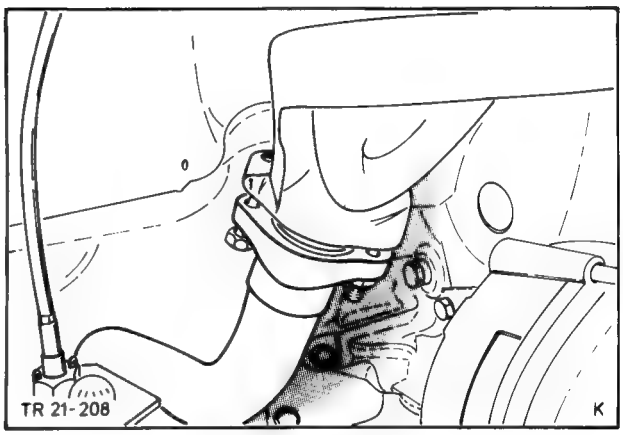


Fig. 17. Unbolt exhaust pipe ('B' engine)

13. Attach engine lifting bracket to engine. Remove both engine mountings by undoing the four bolts of each from the block and the lower nut of rubber insulators. Remove clutch housing cover (3 bolts or 2 clips).
14. Disconnect engine from clutch housing flange (6 bolts) and at the same time detach earth and positive leads of battery when applicable.
15. Support gearbox, move engine forwards with engine lifting gear and lift out of vehicle, Fig. 18.

    NOTE: Turn 'A' engine at right angles to longitudinal axis of vehicle before lifting it out.

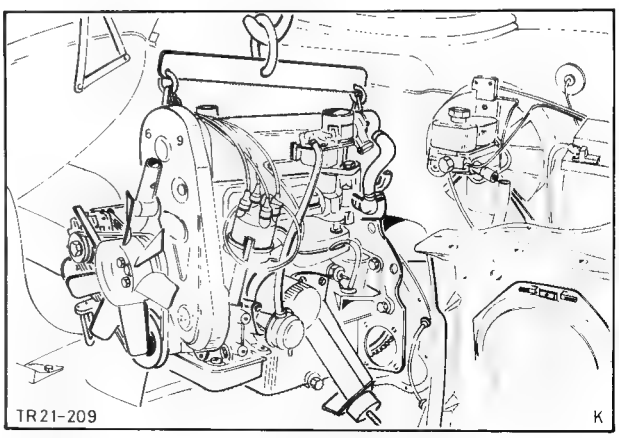


Fig. 18. Lift out engine with Special Tool 21–068

To Install

16. If necessary, transfer guide bushes from clutch housing to engine block and attach adaptor plate, Fig. 19. Lightly grease input shaft.

    Make sure clutch release lever is located correctly.

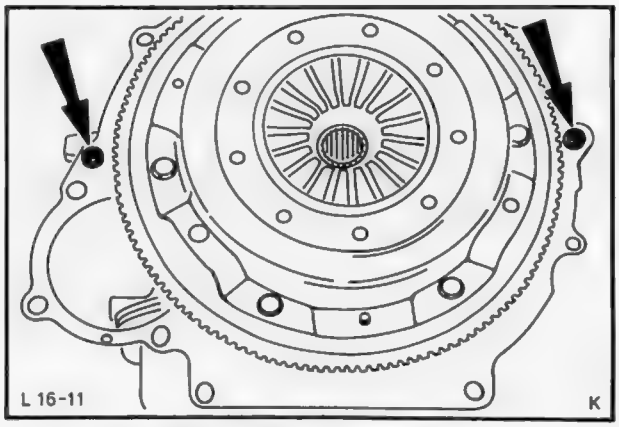


Fig. 19. Clutch housing dowel bushes, 'B' engine

17. Locate engine in vehicle using lifting gear.

    NOTE: Insert 'A' engine at right angles to longitudinal axis of vehicle and turn inside engine compartment.

    Slide engine on gearbox input shaft until it comes to rest against clutch housing flange then tighten bolts to prescribed torque. Refer to Technical Data. Also attach battery earth and positive leads when fitted. Remove support from gearbox.

18. Bolt engine mountings to cylinder block and secure rubber insulators to engine bearer to prescribed torque. Refer to Technical Data. Detach engine lifting gear and fit clutch housing cover.

19. Fix exhaust pipe to exhaust manifold with seal and retaining flange. Refit starter motor and connect starter motor lead, Fig. 20.

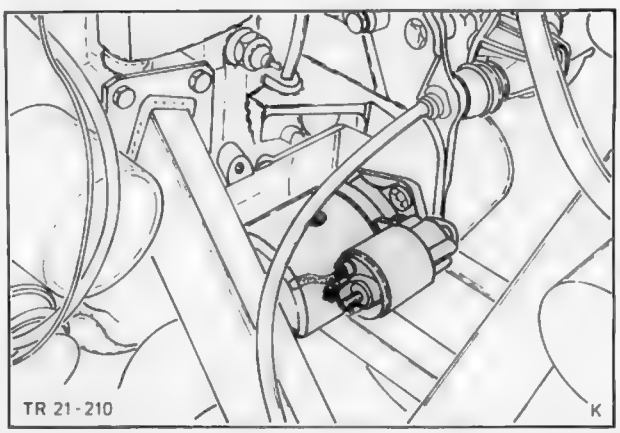


Fig. 20. Starter motor fitted in position ('B' engine)

20. Check clutch play and adjust if necessary. Reconnect leads to alternator, temperature gauge sender unit oil pressure switch and coil.

21. Connect brake servo vacuum hose to inlet manifold and attach lead to idling shut-off valve, Fig. 21.

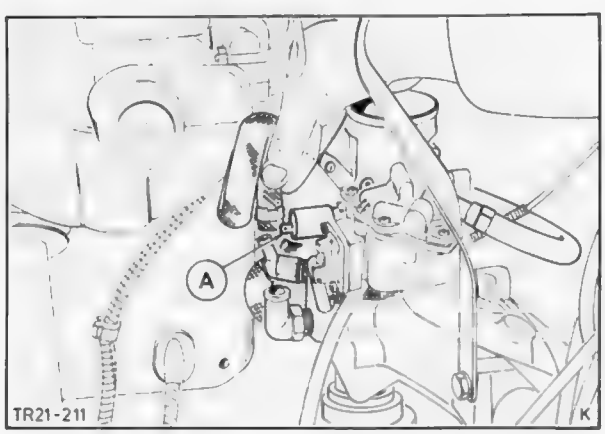


Fig. 21. Brake servo vacuum hose ('A' engine)
A – Idling cut-off valve

22. Secure fuel line to petrol pump. Attach throttle cable to throttle linkage and bolt retaining bracket securely to inlet manifold. Attach choke operating cable and adjust.
23. Attach heater hoses to water pump and automatic choke or inlet manifold, Fig. 22.
24. On the 'A' engine, install radiator complete with fairing and bolt securely.

Sub operations 25 and 26 only apply to 'B' engine.

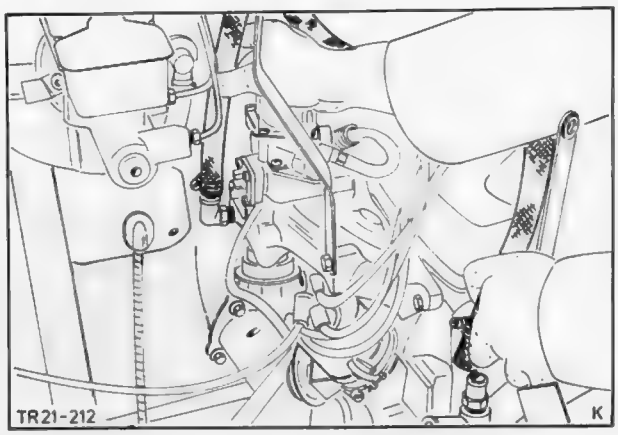


Fig. 22. Attach heater hoses ('A' engine)

25. Install radiator grille complete with radiator, Fig. 23, and bolt securely. Attach bumper with bracket and fit side pieces.
26. Refit both headlamp units. Connect hood cable to catch spring and secure to radiator grille panel. Adjust hood cable, Fig. 24.
27. Attach top and bottom radiator hoses and tighten fixing clips. Pour in coolant. Check engine oil level, topping up if necessary.
28. Attach hood and align correctly.

    Slip hose of screen-washer onto T-piece and secure.
29. Attach earth lead to battery and complete engine adjustments at normal working temperature. Refer Sections 22 and 23A. Dwell angle, ignition timing, idling speed and CO content.
30. Recheck coolant level after reaching thermostat opening temperature. Then fit air cleaner.

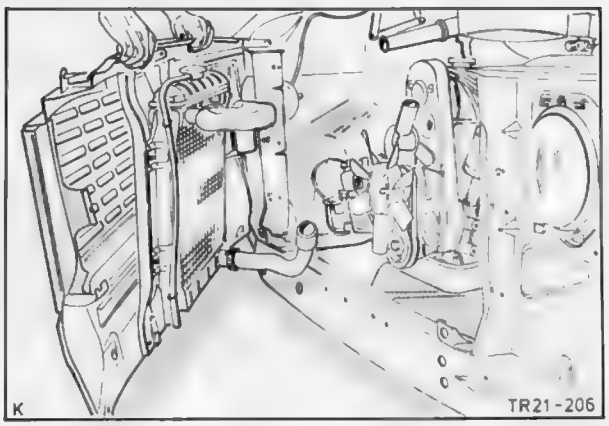


Fig. 23. Install radiator grille panel with radiator (only necessary with 'B' engine)

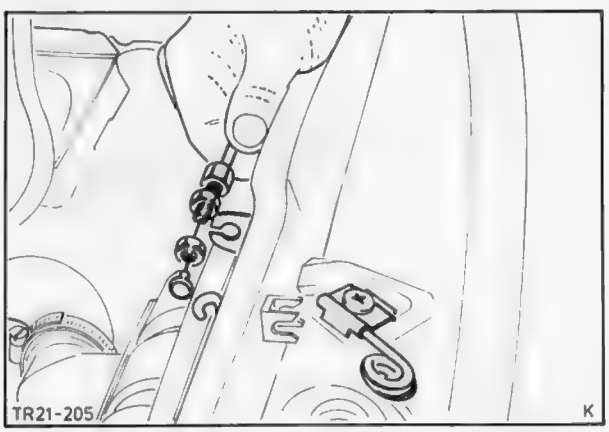


Fig. 24. Attach hood cable (only necessary with 'B' engine)

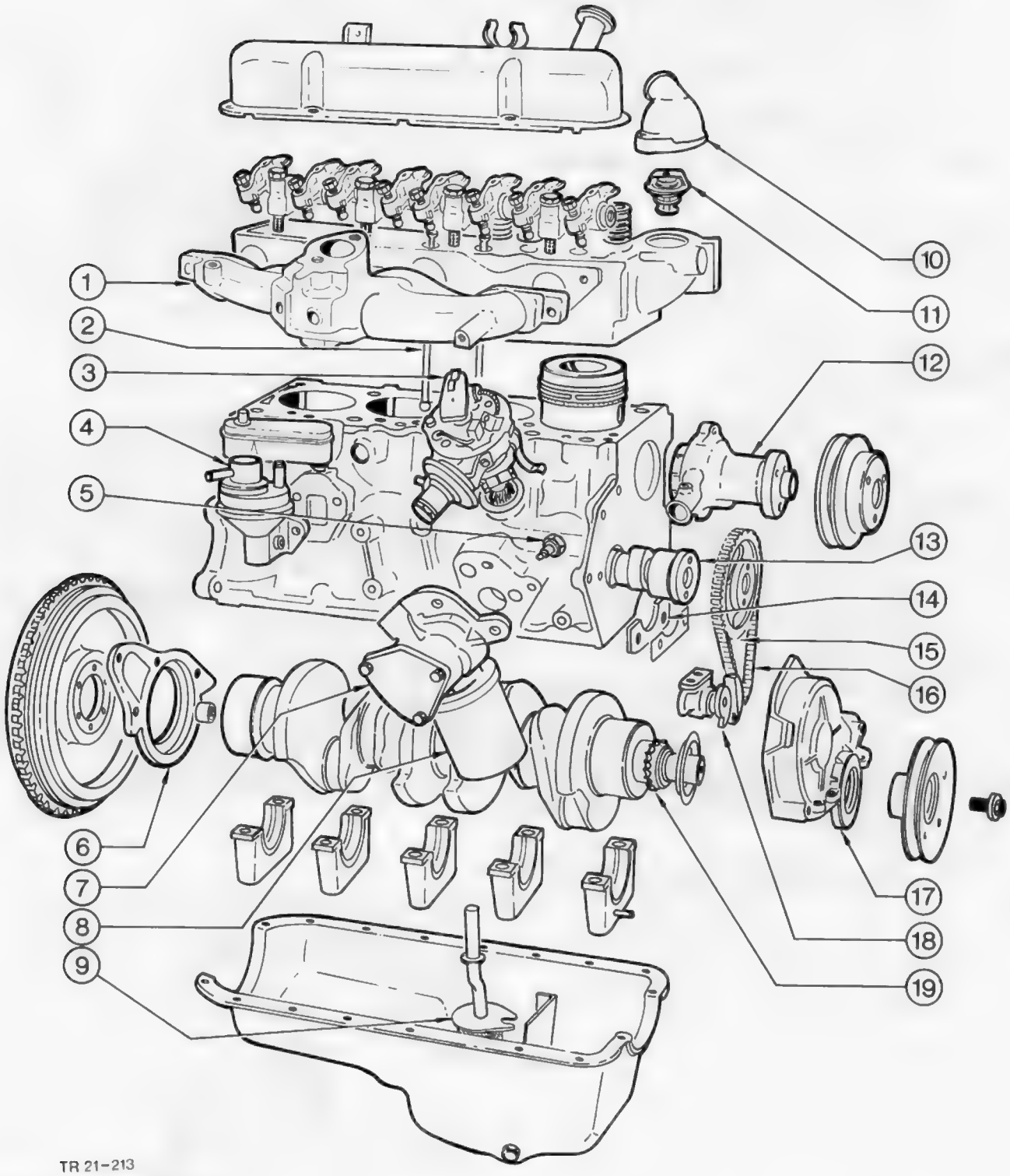


Fig. 25. 'A' engine, exploded view

1. Inlet manifold
2. Valve pushrod
3. Distributor
4. Petrol pump
5. Oil pressure switch
6. Crankshaft oil seal carrier
7. Oil pump
8. Oil filter
9. Oil pump strainer with suction pipe
10. Water outlet connection
11. Thermostat
12. Water pump
13. Camshaft
14. Camshaft thrust plate
15. Camshaft sprocket
16. Timing chain
17. Timing cover with gasket
18. Chain tensioner
19. Crankshaft sprocket

Lubrication circuit, Fig. 26

The oil pump draws oil via a strainer from the oil sump and feeds it into the full-flow oil filter. The filtered oil, passing along the central axis of the oil filter cartridge, reaches the oil pressure switch via a short drilling (on the right-hand side of the engine) and the main oil gallery (on the left-hand side of the engine) via a transverse drilling. The main bearings have direct connections to the main oil gallery and the camshaft bearings in their turn have connections to the front, centre and rear main bearings. The big end journals are supplied with oil through diagonal drillings from the nearest main bearing. An oil bore in the big end ensures splash lubrication of the piston pins and the trailing side of cylinders. The timing chain and sprockets are also lubricated via a splash oil drilling. The front bearing journal of the crankshaft has a pad at its centre from which the pressurised oil is supplied intermittently to the rocker shaft (via a drilling in the cylinder block and cylinder head).

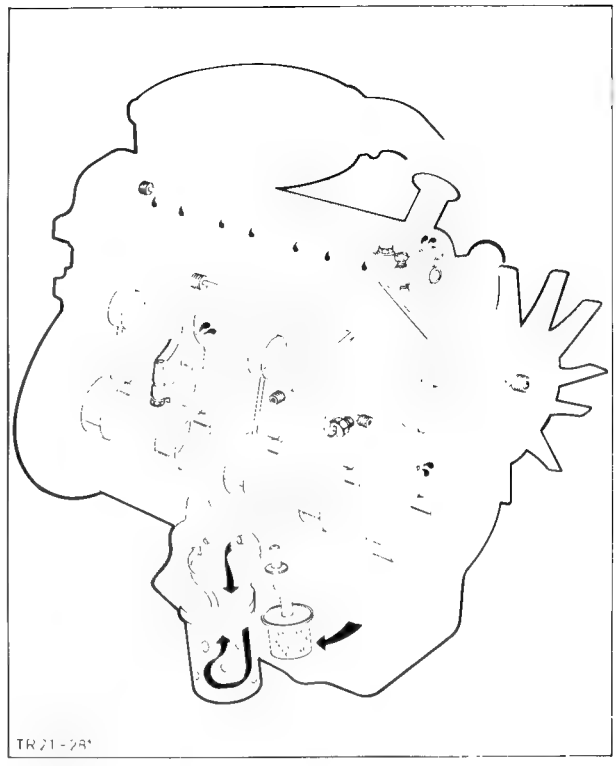


Fig. 26. Oil flow

Closed ventilation system, Fig. 27

The ventilation of the crankcase depends on the amount of air drawn by the engine when it is running and on the throughput of the vent valve. Fresh air enters at the rocker cover via the oil filler neck, flows through the crankcase and is drawn in by the running engine through the vent valve on the right hand side of the engine and burnt with the carburettor mixture. The vent valve controls the rate of air flow as a function of the engine load.

The vent valve, like the steel-wool filter in the oil filler cap, must be cleaned with a cleaning agent and/or replaced at the specified intervals.

Fig. 27. Closed ventilation system

21 134 8 ENGINE ASSEMBLY – DISMANTLE AND REASSEMBLE (Engine removed)

Special Service Tools Required:

Engine stand	Löwener or Churchill
Universal spindle	21–023
Crankshaft rear oil seal installer	21–030
Engine mounting bracket	21–031
Cylinder head bolt wrench	21–034
Crankshaft bearing remover	21–036
Flywheel bearing installer and clutch disc aligner	21–080

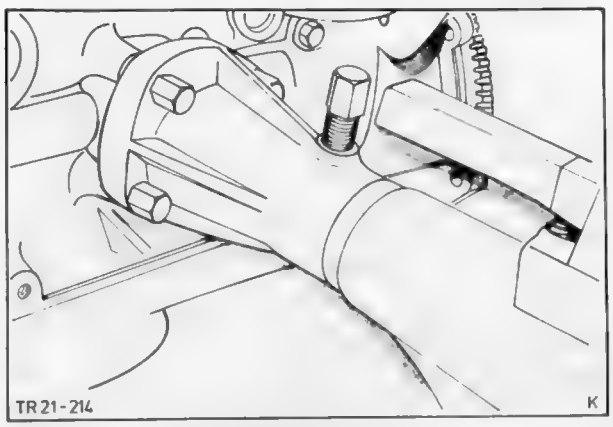


Fig. 28. Secure engine to stand using mounting bracket 21–031

To Dismantle

1. Secure engine to stand by means of engine mounting bracket 21–031, and universal spindle 21–023, Fig. 28.
2. Remove clutch pressure plate (6 bolts) and clutch disc from flywheel, Fig. 29.

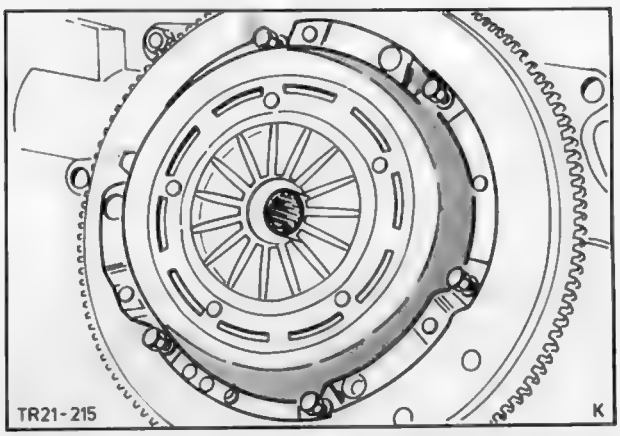


Fig. 29. Remove clutch pressure plate with clutch disc from flywheel

3. Drain engine oil and remove oil filter using oil filter wrench, Fig. 30.
4. Disconnect HT leads and remove distributor cap and leads. Remove spark plugs.
5. Disconnect vacuum advance line from carburettor.

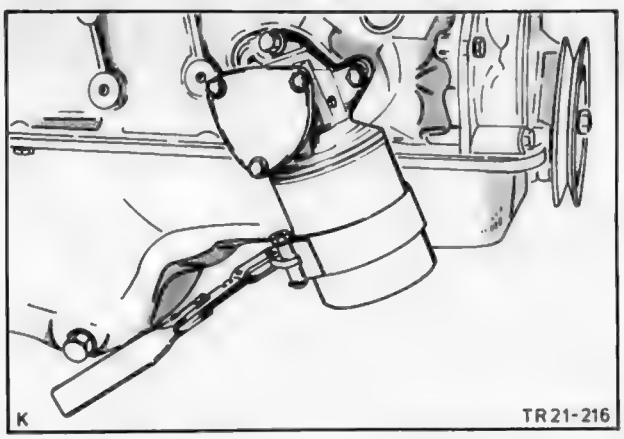


Fig. 30. Remove oil filter

6. Disconnect fuel line from carburettor and withdraw breather hose together with vent valve from oil separator.
7. Slacken alternator bracket. Take off V-belt and remove alternator with its bracket (3 bolts), Fig. 31. Remove fan and pulley (4 bolts).

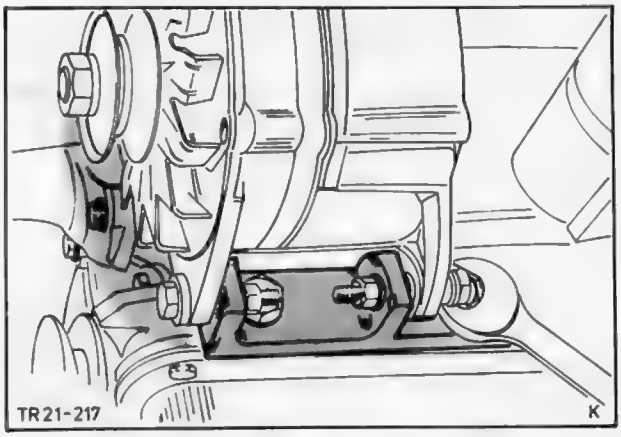


Fig. 31. Remove alternator with bracket

8 Remove crankshaft pulley (1 bolt), using Special Tool, Fig. 32 and rocker cover (4 screws).
9. Remove water connection (2 bolts). Remove gasket and take thermostat out of cylinder head.

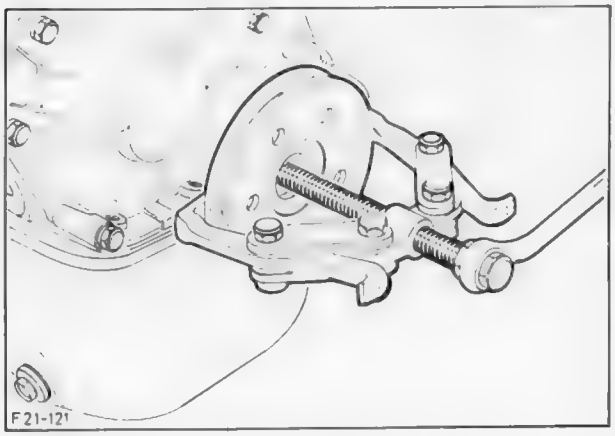


Fig. 32. Pull off crankshaft pulley using Special Tool

10. Detach rocker shaft (4 bolts), Fig. 33, and remove push rods. **Do not interchange push rods when reinstalling.**
11. Remove cylinder head bolts (10 bolts), unscrewing them in reverse order from that in which they were tightened.
(See Fig. 67 for tightening sequence.)

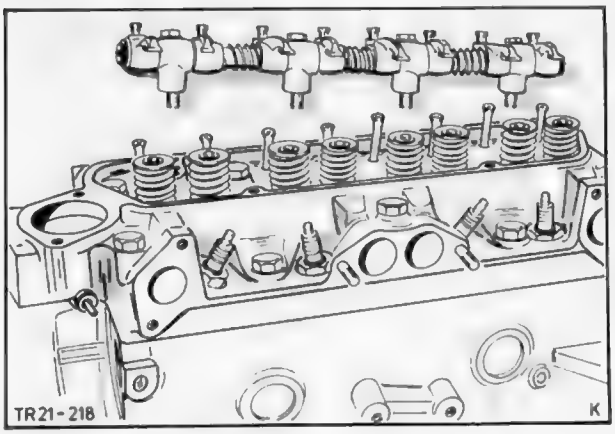


Fig. 33. Remove rocker shaft

12. Lift off cylinder head complete with inlet and exhaust manifolds.
13. Detach fuel pump (2 bolts) together with spacer, Fig. 34.

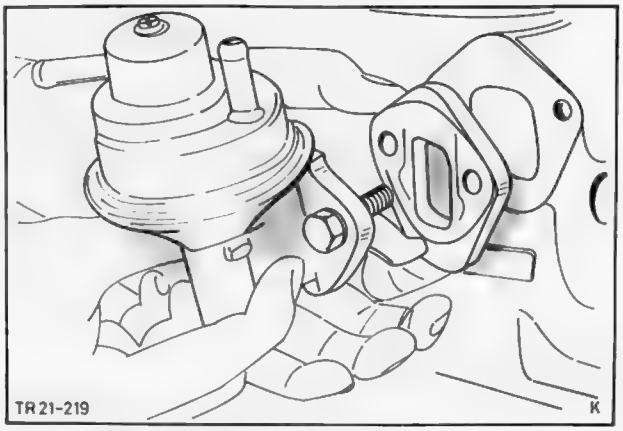


Fig. 34. Remove fuel pump

14. Withdraw bolt from oil separator. Prise oil separator out of engine block, using a screwdriver, Fig. 35.
15. Remove distributor (1 bolt) and detach oil pump (3 bolts). Remove oil pressure switch.

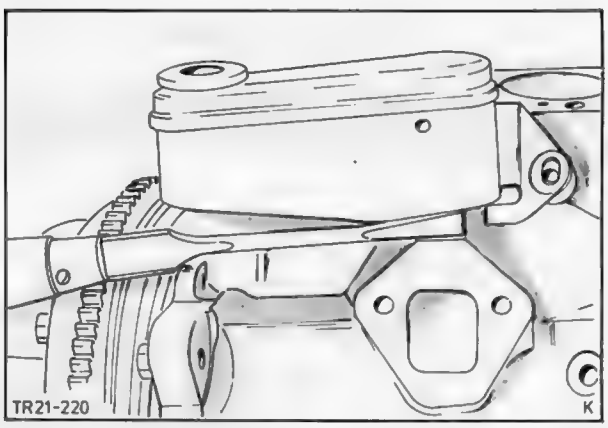


Fig. 35. Remove oil separator using a screwdriver

16. Remove sump, Fig. 36. Detach sump with engine mounted upright in the stand. This is to avoid sludge or swarf getting into engine.
17. Set pistons at centre of their stroke and remove carbon deposits from cylinder head faces using a suitable scraper, without touching piston bore.

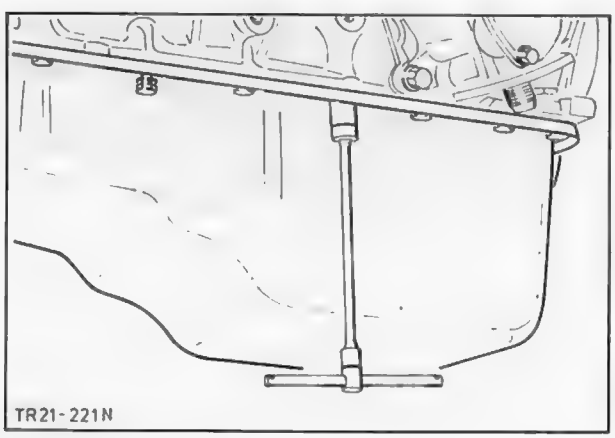


Fig. 36. Detach oil sump

18. Place a large tray under engine, invert engine and catch remaining oil, the carbon which has been detached and coolant.

19. Remove water pump (3 bolts), Detach timing cover (4 bolts) and remove oil slinger from crankshaft, Fig. 37.

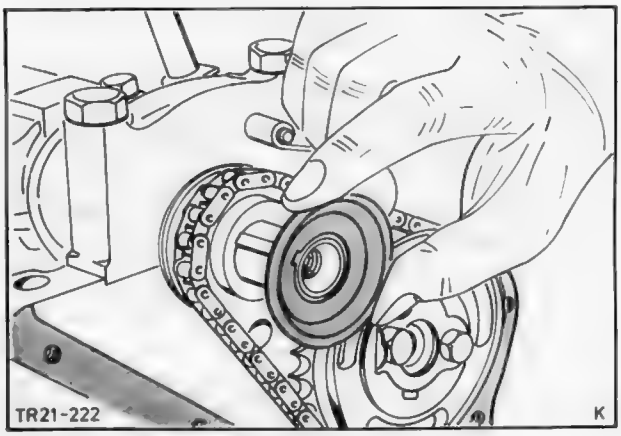


Fig. 37. Remove oil slinger

20. Detach oil pump suction pipe (1 bolt) and moving it to and fro, withdraw it from cylinder block.

21. Withdraw tensioner arm from pin of front mainbearing cap and detach chain tensioner (2 bolts), Fig. 38.

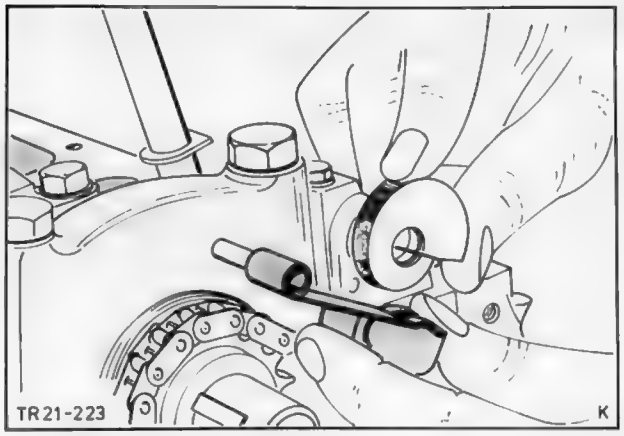


Fig. 38. Detach chain tensioner arm

22. Bend over lock tabs, remove two bolts and detach camshaft gear complete with timing chain, Fig. 39.

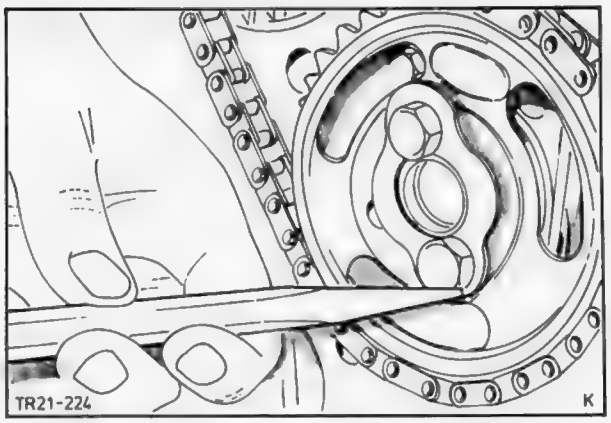


Fig. 39. Bend back camshaft sprocket lock tab

23. Remove camshaft thrust plate (2 bolts), Fig. 40.

24. Withdraw camshaft towards front, having first turned camshaft through 360° to bring all tappets into TDC position. Remove tappets.

Do not interchange tappets when re-assembling.

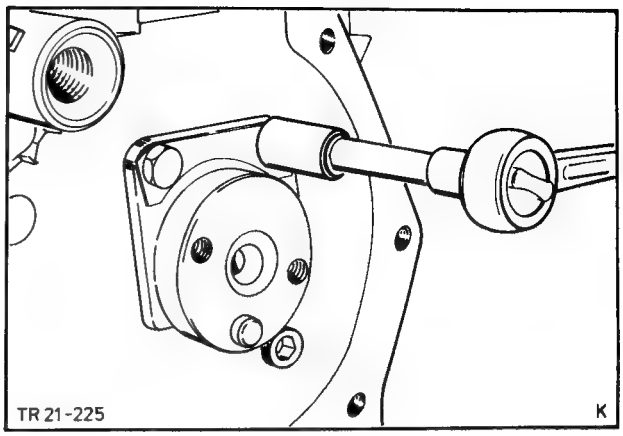


Fig. 40. Remove camshaft thrust plate

25. Remove input shaft spigot bearing from crankshaft using Special Tool 21–036, Fig. 41.

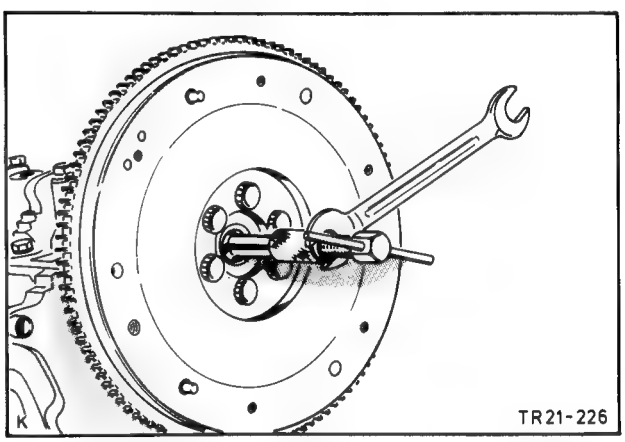


Fig. 41. Withdraw crankshaft needle bearing using Special Tool 21–036

26. Pull off crankshaft gear using standard puller, Fig. 42.

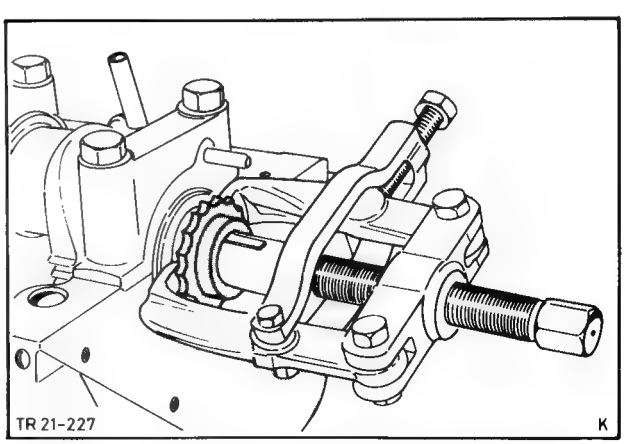


Fig. 42. Pull off crankshaft sprocket using standard puller

27. Check markings of big end and main bearing caps, Fig. 43, for subsequent reassembly.

28. Remove big end bearing caps one by one, together with bearing shells. Push pistons complete with connecting rods and bearing shells out of engine. If big end bearing shells are removed before pistons are taken out, mark shells to correspond with connecting rods, for purposes of subsequent reassembly.

29. Detach flywheel (6 bolts) and rear cover plate.

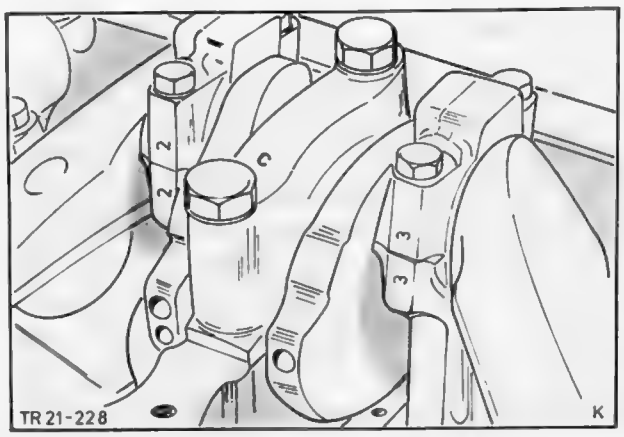


Fig. 43. Markings of big end bearing caps

30. Remove rear oil seal carrier (4 bolts), Fig. 44.

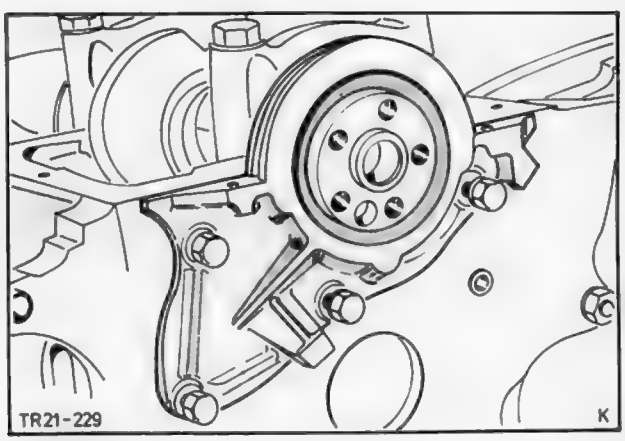


Fig. 44. Remove rear oil seal carrier

31. Remove main bearing caps complete with bearing shells.

32. Lift crankshaft out of the cylinder block, remove bearing shells and both half thrust washers of middle main bearing, Fig. 45, and mark for possible re-use.

33. Remove oil seals from timing cover and rear oil seal carrier.

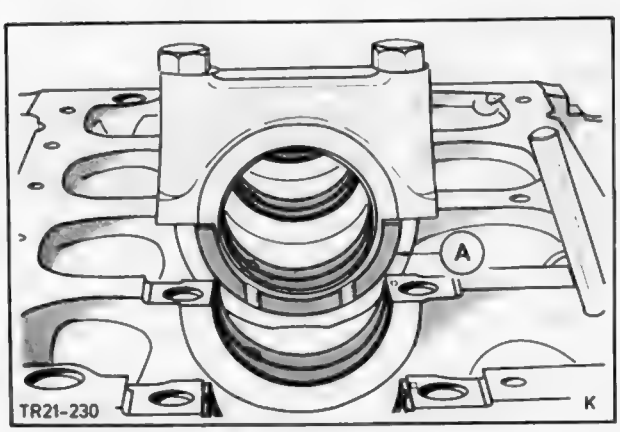


Fig. 45. Cylinder block with half thrust washer fitted
A – Half thrust washer

To Reassemble

The type and degree of cleaning of a given part before reassembly must depend on the hours the engine has run, the extent of any damage and its possible re-use. This applies particularly to the cylinder block with its corners, angles and bores. If necessary, remove all plugs and covers and clean their seats, using suitable cleaning agents and tools (brushes, scrapers). The oil galleries in particular, e.g. in the cylinder block, cylinder head, etc. should be free from dirt and abrasive particles, Fig. 46. If press-fit plugs and screw plugs are removed, they, like all seals and gaskets, should be renewed.

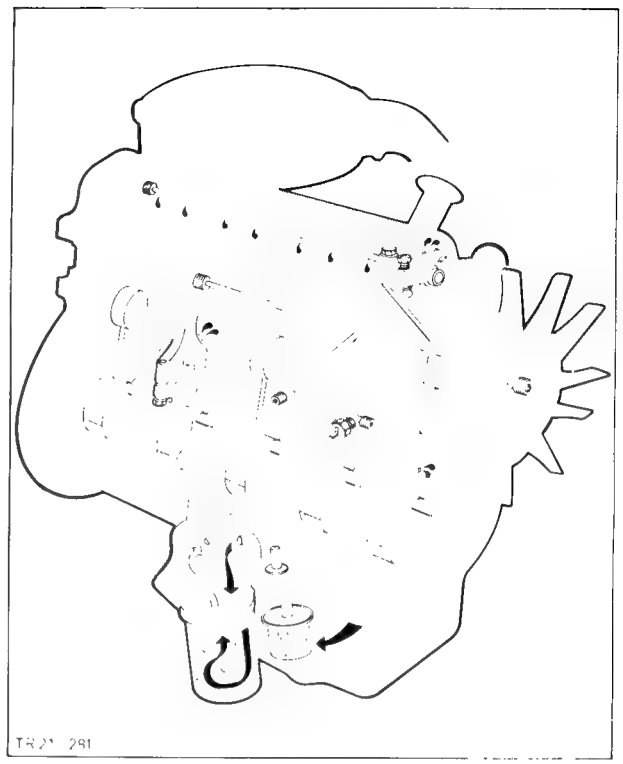


Fig. 46. Oil circuit

Main Bearings

Parent bore in cylinder block

The parent bore in the cylinder block may be either standard or 0,38 mm (0,015 in) oversize. There is no marking for the standard parent bore, but with an oversize bore the bearing caps are marked with white paint, Fig. 47.

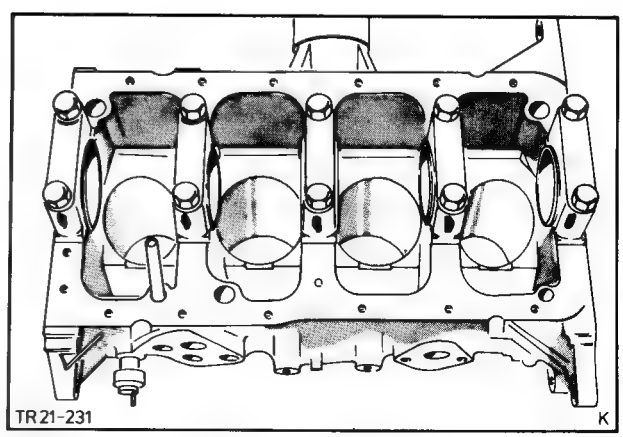


Fig. 47. Colour marking of main bearing caps

Crankshaft main bearing journals

The crankshaft main bearing journals may be standard or (also in new engines) 0,25 mm (0,01 in) undersize. Standard main bearing journals are not marked, while the crankshaft web adjacent to an undersize main journal is marked with a green stripe, Fig. 48.

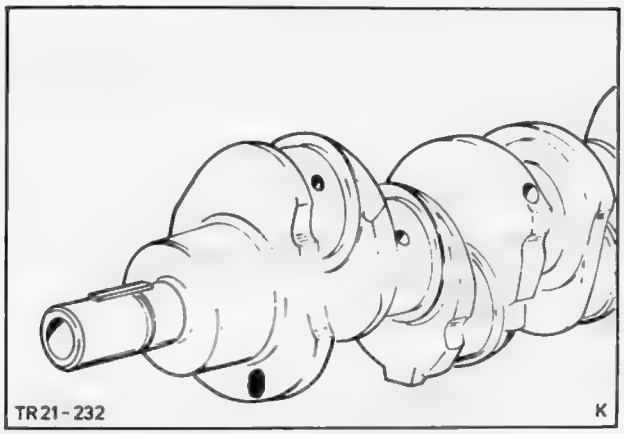


Fig. 48. Colour marking of main bearing journal

Big end bearing journals

The big end bearing journals may also be standard or (also in new engines) 0,25 mm (0,01 in) undersize.

Standard big end bearing journals are not marked, while the undersize is marked with a green paint spot on the web next to the journal, Fig. 49.

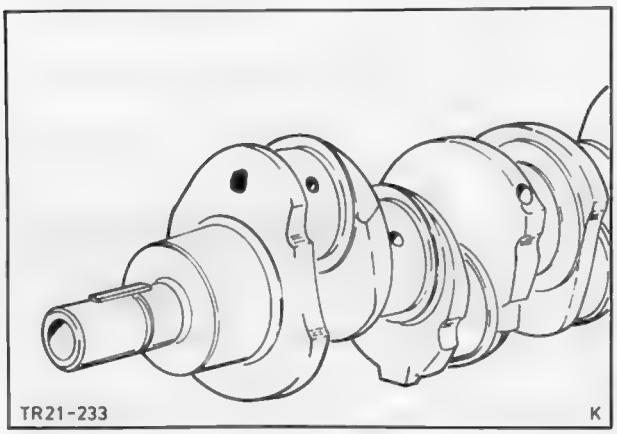


Fig. 49. Big end bearing journal colour marking

Bearing shells

Standard main bearing and big end bearing shells are not marked. Bearing shells for undersize crankshafts or oversize cylinder blocks have an appropriate inscription on the back (see Parts Catalogue) while colour markings on production repair sizes are on the outer edge at the side, Fig. 50, with the exception of pure service main and big end bearing shells (0,5/0,75/and 1,0 mm (0,02/0,03/0,04 in) undersize crankpins).

When selecting new bearing shells, it should be verified against the Parts Catalogue that they are the appropriate ones and, in addition, they should be measured.

In order to remain within the specified tolerances (see Technical Data), the journals, parent bores and bearing shells should be measured individually.

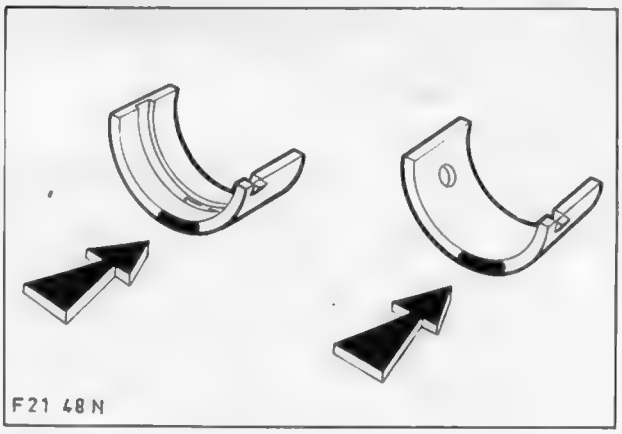


Fig. 50. Bearing shell colour coding (Production-repair size)

Measuring bearing clearance

Measuring bearings (even with undersize crankshafts) can be eliminated and determination of required bearing shells can be considerably simplified by use of:

'PLASTIGAGE' (type PG 1) made by:
PERFECT CIRCLE CORPORATION
HAGERSTOWN, INDIANA, USA.

UK Supplier:
NORMAN GAYDON (International) Ltd.
68 London Road
Southend-on-Sea
Essex.

West German supplier:
K. H. ERN/Motorenteile GmbH
Schinkelstrasse 46–48
D-4000 Dusseldorf.

'PLASTIGAGE' is the name of an accurately calibrated plastic filament.

Requirements for use of 'Plastigage'

1. Bearing should be dry and clean.
2. Crankshaft should not be turned during measuring operation.
3. Points of measurement should be close to top and bottom dead centre position.
4. Bearing caps should not be seated with hammer blows.

Procedure

Place length of Plastigage across width of bearing on crankshaft or big end journal, Fig. 51. Fit main or big end bearing cap together with bearing shells and torque as specified. The plastic filament will be compressed more or less depending on bearing clearance. Remove bearing cap.

Each main bearing should be measured separately without other bearing caps being fitted.

Width of compressed plastic filament can be measured by means of scale printed on PLASTIGAGE pack, Fig. 151, reading shows bearing clearance.

Only bolts in good condition should be used for securing bearing caps on crankshaft and they should not be tightened in excess of specified torque.

Measuring Piston Clearance

Procedure

1. When reassembling an engine the piston to bore clearance should be measured as follows.
2. The diameter of the piston should be measured when cold, using a micrometer. The measurement should be made across the piston skirt at 90° to the piston pin axis.
3. This micrometer reading is then used to 'zero' a bore gauge. The reading on the dial of the bore gauge in situ is the piston to bore clearance (see Technical Data).
   Alternatively, the bore can be measured with an internal micrometer, and the piston size subtracted to give the piston to bore clearance.
4. The measurement must be taken below any visible wear marks in the bore. To detect bore ovality, two readings should be taken at 90° to each other.
   NOTE: The maximum difference between these two readings should not be more than 0,025 mm (0,001 in).
5. Inspect the bores for visible wear, damaged lips, etc.
6. If the clearance in sub-section 3 above is excessive, or if ovality, or any of the faults in sub-section 5 above is detected, the block should be rebored to suit oversize pistons.
7. Before installing pistons, check piston ring gaps.
8. Before fitting the pistons, check ring gaps (Fig. 52). Indicated values (see Technical Data) are for the gauge ring used in production and can be exceeded by 0,15 mm, measuring in the cylinder.

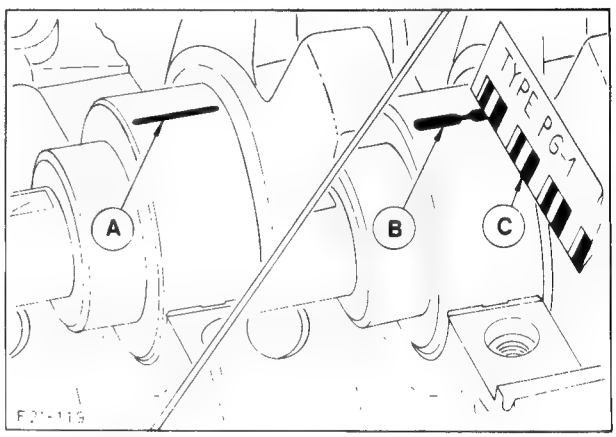


Fig. 51. Measuring bearing clearance
A – Calibrated plastic filament
B – Compressed filament
C – Scale

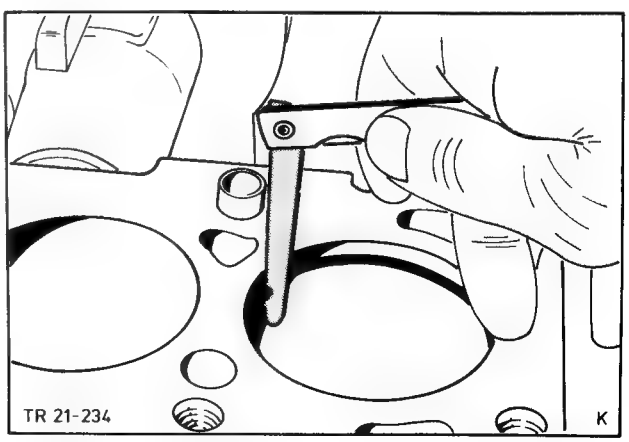


Fig. 52. Check piston ring gaps

To Assemble

34. Press oil seal into oil seal carrier using Special Tool 21–030 and oil Seal into timing cover using a suitable tube, Fig. 53.

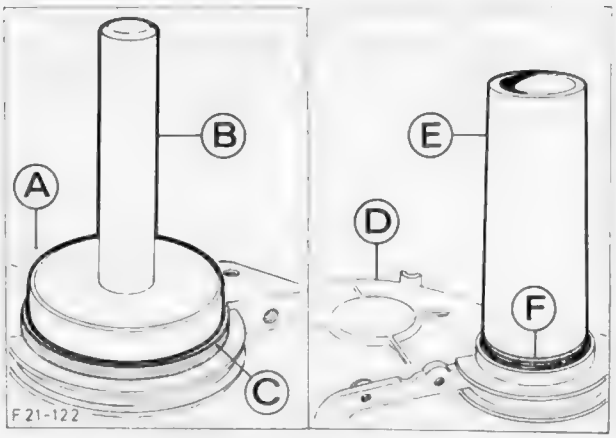


Fig. 53. Press in oil seals
A – Oil seal installer
B – Secial Tool 21–030
C – Oil seal
D – Front cover
E – Tube
F – Oil seal

35. Insert new crankshaft spigot bearing using Special Tool 21–080, Fig. 54, and press into crankshaft. Line up crankshaft sprocket on spring washer and press on.

36. Oil tappets and insert them into cylinder block.

37. Oil camshaft bearings, camshaft and thrust plate. Insert camshaft from front. Attach thrust plate and torque as specified and lock bolts with lock tabs.

38. Insert main bearing shells and half thrust washers dry in block, apply engine oil and then fit crankshaft.

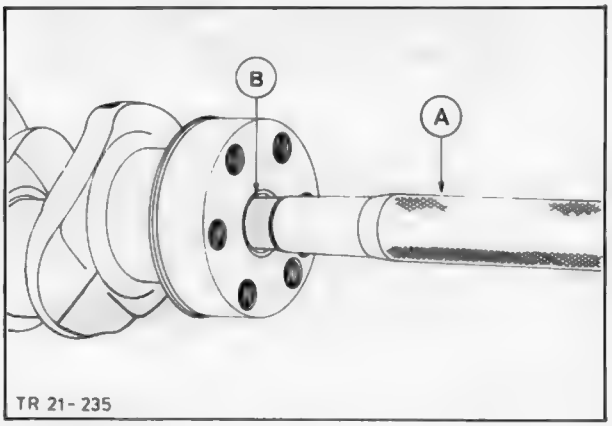


Fig. 54. Press crankshaft needle pilot into position
A – Special Tool 21–080
B – Guide bearing

39. Fit main bearing caps complete with oiled bearing shells.

The arrows on main bearing caps should point towards front of engine. Fig. 55.

40. Tighten bearing cap bolts uniformly to torque specified in Technical Data.

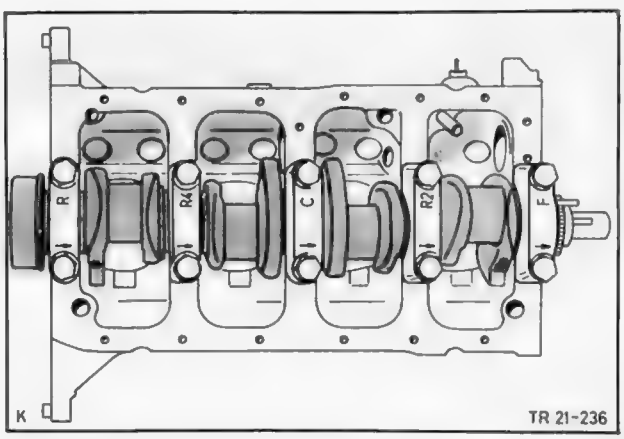


Fig. 55. Main bearing caps in position

41. Check end-float of the crankshaft and camshaft using a dial indicator, Fig. 56. (See Technical Data). If end-float is excessive, fit thicker half thrust washers or a new camshaft thrustplate.

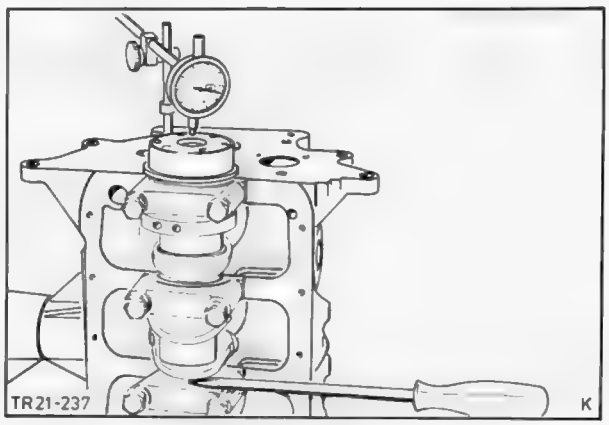


Fig. 56. Check end-float of crankshaft

42. Fit camshaft gear together with timing chain, ensuring markings on gears align, Fig. 57. Torque bolts as specified in Technical Data and lock.

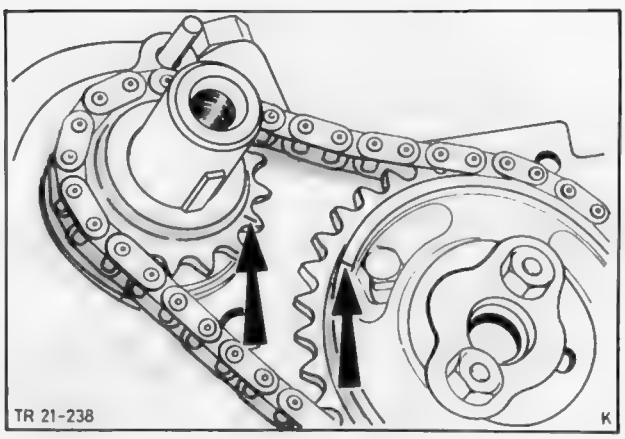


Fig. 57. Sprocket markings

43. Fit timing chain tensioner and torque bolts as specified. Compress spring and slide tensioner arm on to pin on main bearing cap. Release chain tensioner spring, Fig. 58.

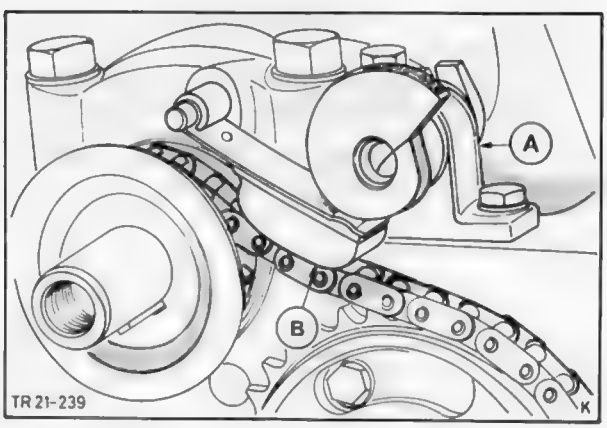


Fig. 58. Chain tensioner installed
A – Chain tensioner
B – Tensioner arm

44. Slide on oil slinger. Centre front cover equipped with a new oil seal (sealing lip lightly lubricated) with crankshaft pulley, Fig. 59.

45. Tighten bolts of front cover and crankshaft pulley to specified torque.

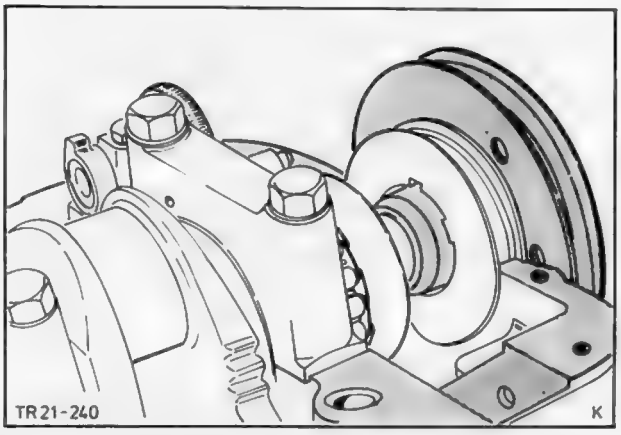


Fig. 59. Centre front cover with crankshaft pulley

46. Refit rear oil seal carrier fitted with a new oil seal (sealing lip lightly lubricated). Tighten oil seal carrier bolts to specified torque.

47. Invert engine and position rear cover. Fit flywheel, Fig. 60, and torque as specified in Technical Data.

Re-use only bolts, which are in good condition and lubricated.

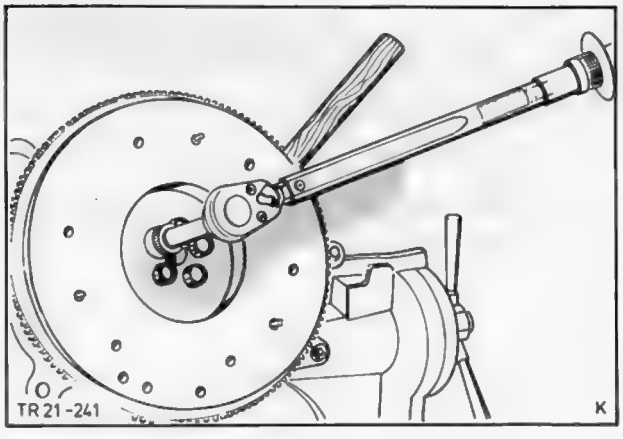


Fig. 60. Fit flywheel

48. Position clutch disc using Special Tool 21–080, Fig. 61. Place pressure plate on dowels and torque as specified in Technical Data.

49. Apply engine oil to pistons and cylinder bores. Stagger piston rings with specified gaps. Refer to Technical Data.

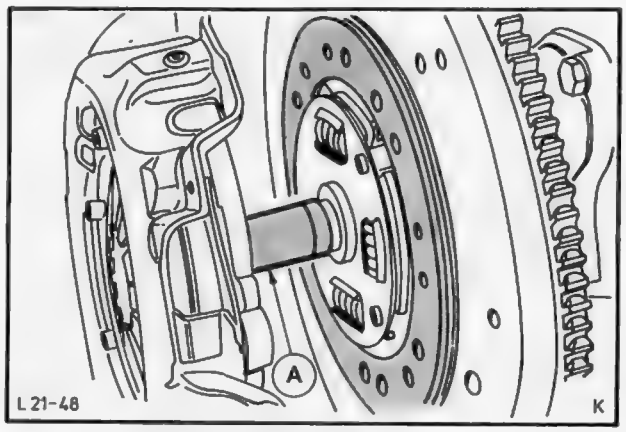


Fig. 61. Centre clutch disc and pressure plate
A – Special Tool 21–080

50. Compress piston rings with a standard tool (ring compressor), Fig. 62. Slide piston into cylinder using a hammer handle, guiding connecting rod on to big end journal by hand.

The 'front' marking on piston (arrow, notches, etc.) should point towards front cover.

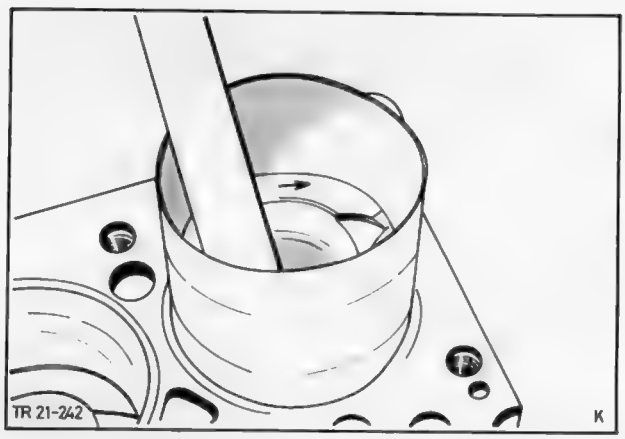


Fig. 62. Fit piston using a ring compressor

51. Place big end bearing shell in position, apply oil and press connecting rod firmly against big end bearing journal.

52. Fit big end bearing cap complete with oiled bearing shell. Torque connecting rod bolts as specified in Technical Data, Fig. 63.

Check whether connecting rods have enough endfloat on journals.

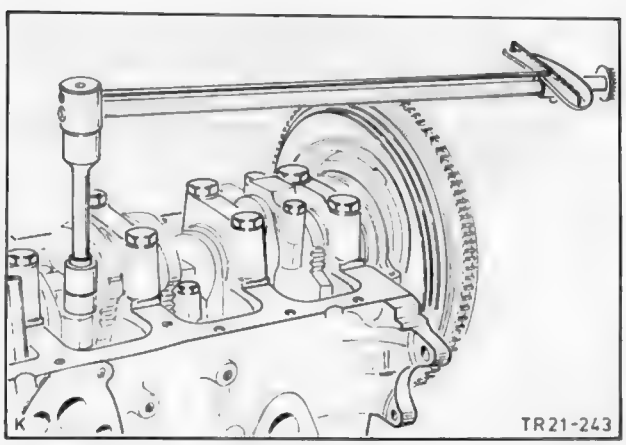


Fig. 63. Torque connection rod bolts as specified in Technical Data

53. Apply metal jointing compound (Loctite) to oil pump suction pipe and press in position. Torque bolts as specified in Technical Data.

54. Insert rubber seal in groove of rear seal carrier and locate cover.

    Apply sealing compound to cylinder block mating surface at joint of cover and rear seal carrier. Place sump gasket in position and slide projections on cork gasket under cut-outs in rubber gasket, Fig. 64.

55. Place sump in position and torque bolts as specified, in two stages.

    1st stage 4,7 Nm (0,4 to 0,7 kgf.m) (4 lbf.ft)

    2nd stage 8,11 Nm (0,8 to 1,1 kgf.m) (7 lbf.ft)

56. Crank engine.

    Insert oil separator up to stop and secure with bolt.

57. Torque oil pressure switch as specified in Technical Data.

58. Fit water pump with gasket, Fig. 65, only tighten bolt of alternator bracket finger-tight.

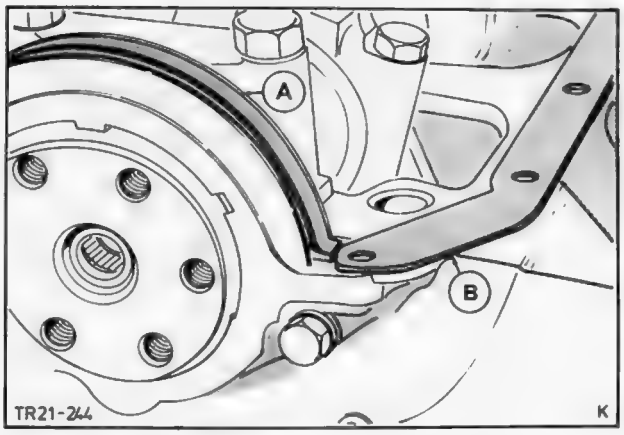


Fig. 64. Fitting sump gasket
A – Rubber half seal of rear oil seal carrier
B – Cork gasket

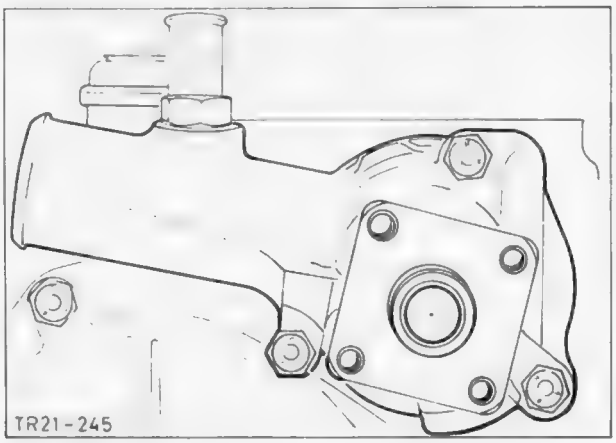


Fig. 65. Install water pump

59. Fit oil pump complete with gasket and torque bolts as specified in Technical Data, Fig. 66.

    When a new or overhauled oil pump is used, it should be turned by hand through a complete rotation and filled with engine oil prior to installation.

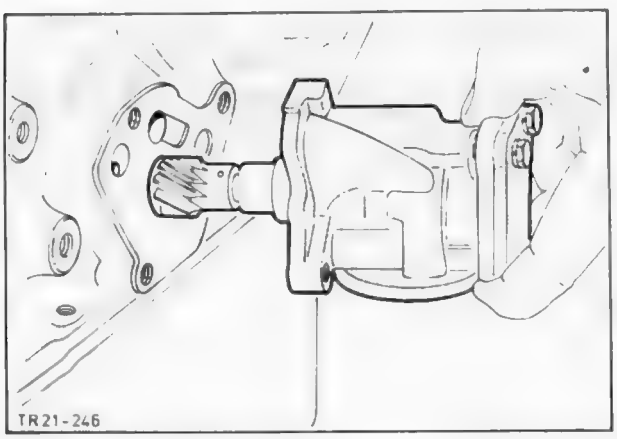


Fig. 66. Fit oil pump

60. Screw on oil filter cartridge until rubber gasket makes contact with filter head, then tighten a further $\frac{3}{4}$ turn. Apply engine oil to rubber gasket and mating flange face before fitting.

61. Position cylinder head gasket correctly.

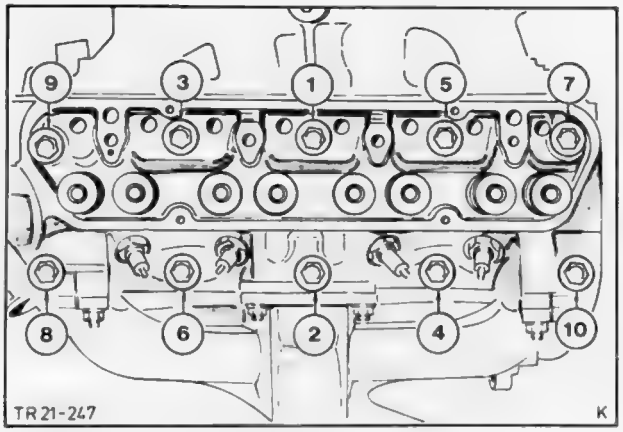


Fig. 67. Tightening sequence for cylinder head bolts

62. Fit cylinder head and tighten bolts finger tight. Torque cylinder head bolts as specified in three stages proceeding in sequence shown in Fig. 67.

1st stage	7 Nm (0,7 kgf.m) (5 lbf.ft)
2nd stage	27 to 40 Nm (2,7 to 4,0 kgf.m) (25 lbf.ft)
3rd stage	68 to 75 Nm (6,8 to 7,5 kgf.m) (53 lbf.ft)

10 to 20 minutes later
88 to 95 Nm (8,8 to 9,5 kgf.m) (67 lbf.ft)
After engine has run for at least 15 minutes retighten to
88 to 95 Nm (8,8 to 9,5 kgf.m) (67 lbf.ft)

Bolts vary in length to suit thickness of cylinder head.

63. Apply engine oil to both ends of push rods and place them in push rod sockets.

64. Place rocker shaft in position, guiding rocker lever adjusting screws into push rod sockets. Tighten rocker shaft bolts by hand, then torque them as specified in Technical Data, Fig. 68.

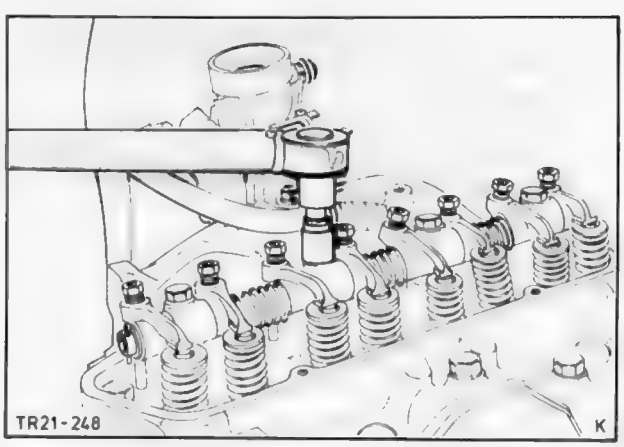


Fig. 68. Tighten rocker shaft bolts

65. Insert thermostat into cylinder head, Fig. 69. Place gasket in position and fit thermostat housing.

66. Adjust valve clearances (see Operation 21 213), refit rocker cover and tighten bolts evenly to specified torque.

67. Fit alternator complete with bracket. Fit fan complete with pulley, to water pump.

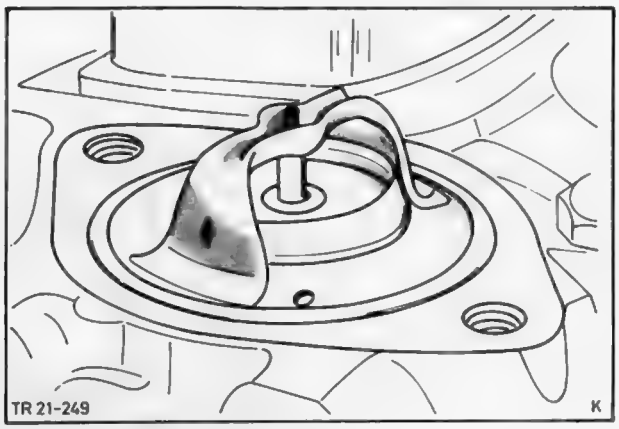


Fig. 69. Thermostat in position

68. Refit fan belt and adjust belt tension to achieve 13 mm (0,5 in) total slackness between alternator and fan.

69. Refit fuel pump with gaskets and spacer. Torque bolts as in Technical Data, Fig. 70.

70. Connect fuel line to carburettor and insert vent valve into oil separator.

71. Set 1st cylinder of engine to TDC (valves of 4th cylinder overlap). Turn rotor arm to mark of 1st cylinder and insert distributor in block.

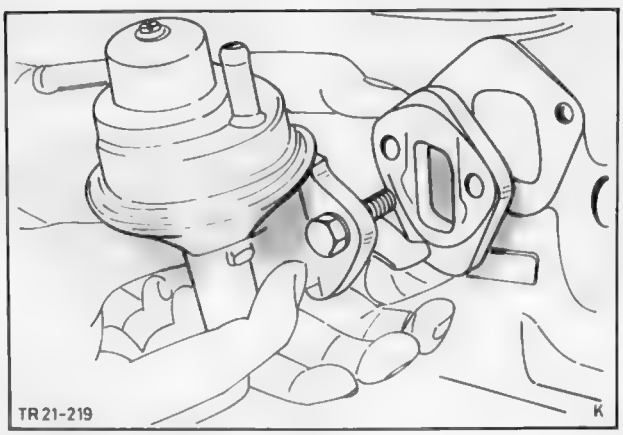


Fig. 70. Fit fuel pump

72. Fit spark plugs and torque as specified in Technical Data. Refit distributor cap and connect HT leads to spark plugs, arranged as shown in Fig. 71. Connect vacuum line to carburettor.

73. Fit oil drain plug complete with new washer and torque as specified in Technical Data.

Every time oil is changed and oil drain plug is removed a new washer should be fitted.

74. Insert dipstick and remove engine from stand.

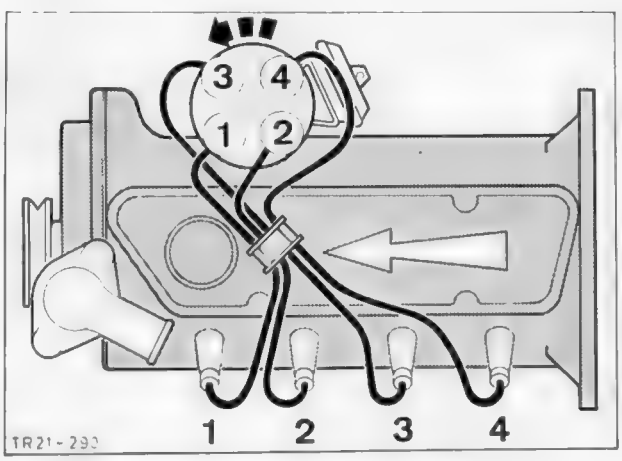


Fig. 71. Arrangement of HT leads (firing order)

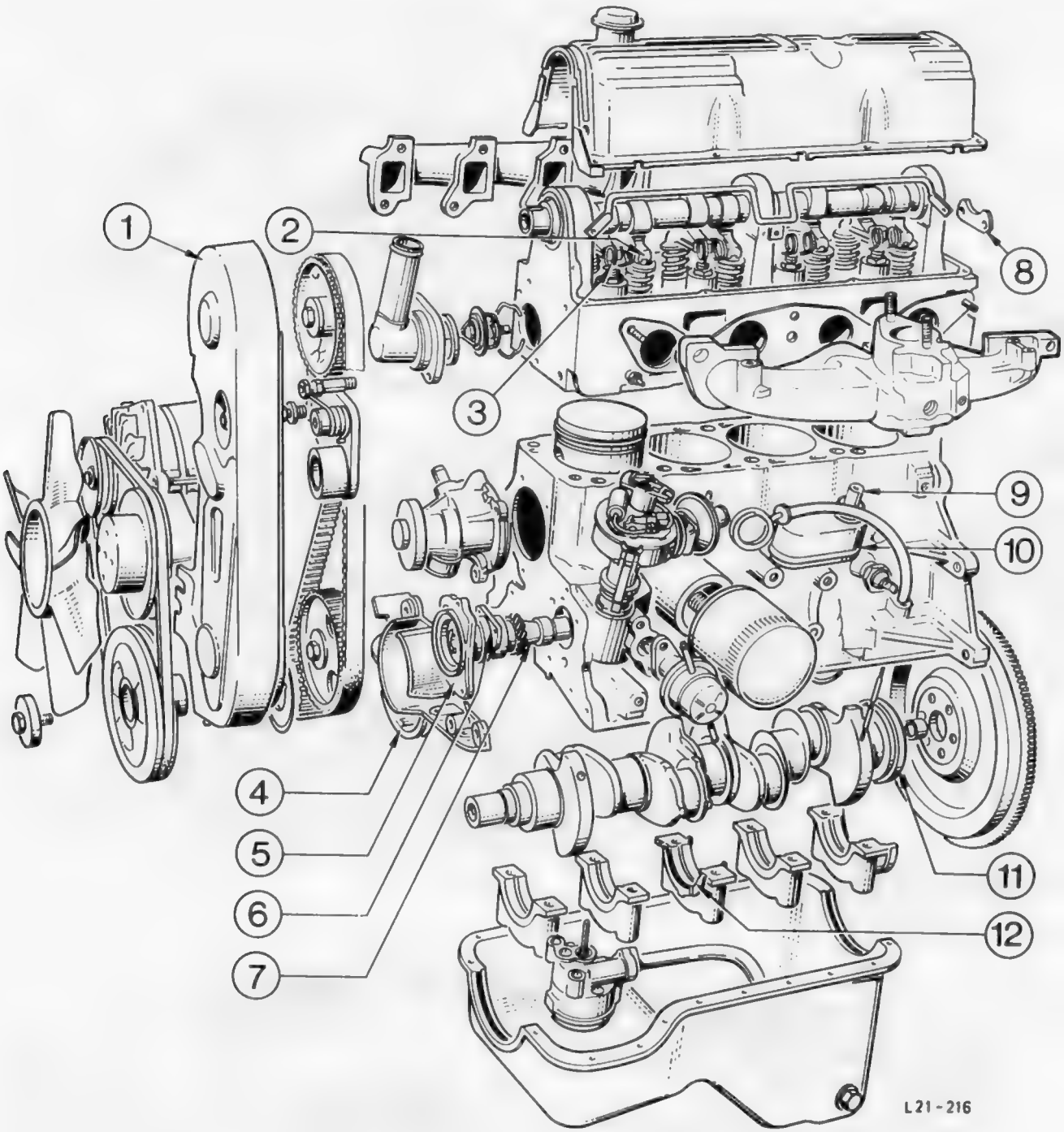


Fig. 72. 'B' engine – exploded view

1. Toothed belt guard
2. Cam follower
3. Cam follower spring
4. Crankshaft timing cover
5. Auxiliary shaft front cover
6. Auxiliary shaft thrust plate
7. Auxiliary shaft
8. Camshaft thrust plate
9. Vent valve
10. Oil separator
11. Crankshaft oil seal
12. Thrust half ring

Lubrication circuit, Fig. 73.

The oil pump draws oil via a strainer from the oil sump and feeds it into the full-flow oil filter. The filtered oil, passing along the central axis of the oil filter cartridge, reaches the oil pressure switch via a short drilling (on the right hand side of the engine) and the main oil gallery (on the left-hand side of the engine) via a transverse drilling. The main bearings have direct connections to the main oil gallery and the camshaft bearings in their turn have connections to the front, centre and rear main bearings. The big end journals are supplied with oil through diagonal drillings from the nearest main bearing. An oil bore in the big end ensures splash lubrication of the piston pins and the trailing side of cylinders. The timing chain and sprockets are also lubricated via a splash oil drilling. The front bearing journal of the crankshaft has a pad at its centre from which the pressurised oil is supplied intermittently to the rocker shaft (via drillings in the cylinder block and cylinder head).

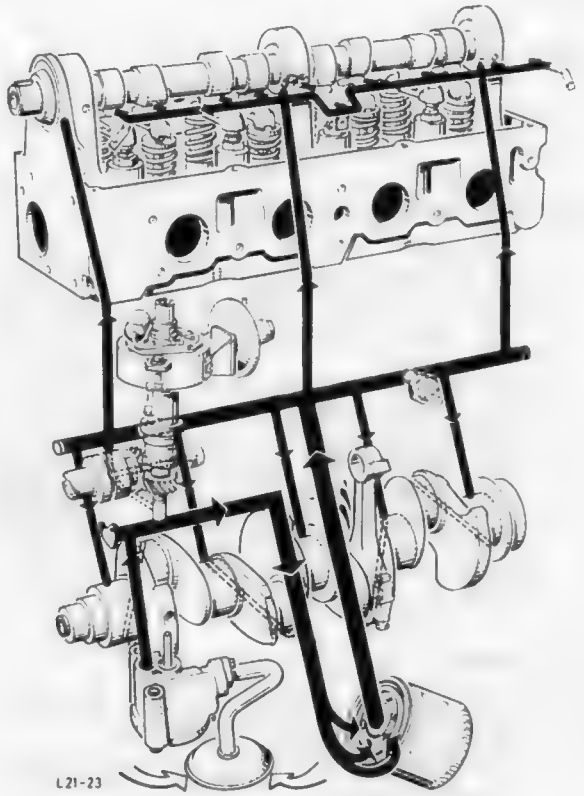


Fig. 73. Oil flow

Closed ventilation system, Fig. 74

The ventilation of the crankcase depends on the amount of air drawn by the engine when it is running and on the throughput of the vent valve. Fresh air enters at the rocker cover via the oil filler neck, flows through the crankcase and is drawn in by the running engine through the vent valve on the right hand side of the engine and burnt with the carburettor mixture. The vent valve controls the rate of air flow as a function of the engine load.

The vent valve and the steel wool filter in the oil filler cap must be cleaned with a suitable cleaner or replaced at the specified intervals.

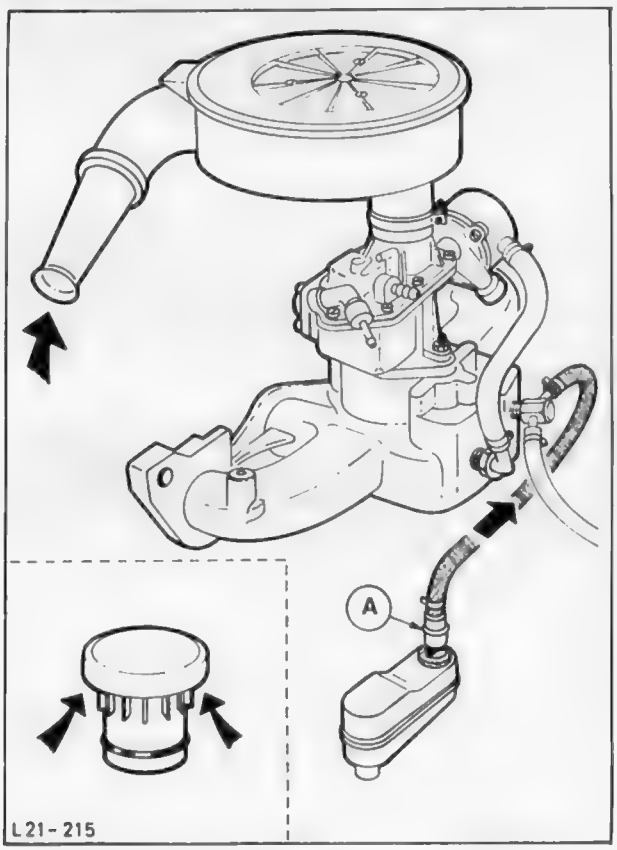


Fig. 74. Closed ventilation system
A – Vent valve

21 134 8 ENGINE ASSEMBLY – DISMANTLE AND REASSEMBLE (Engine removed)

Special Service Tools Required:

Engine stand	
Cylinder head bolt wrench	21–002
Cylinder head alignment studs	21–003
Valve adjustment locknut wrench	21–004–A
Oil seal remover	21–009–A
Crankshaft rear oil seal installer	21–011–A
Oil pump bolt and drive belt tensioner socket	21–012
Universal spindle	21–023
Crankshaft gear remover	21–028
Engine mounting bracket	21–031
Flywheel bearing remover	21–036
Flywheel bearing installer and clutch disc aligner	21–044

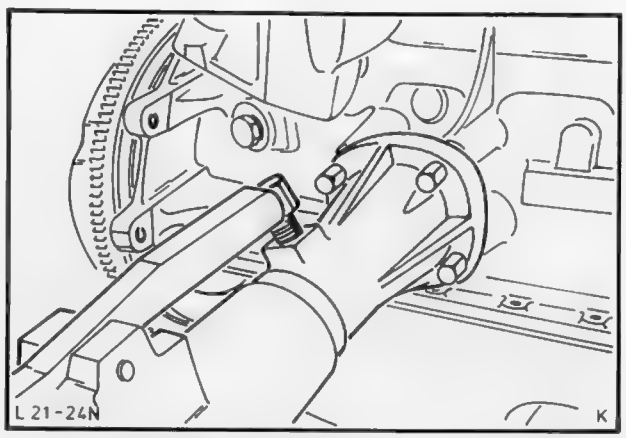


Fig. 75. Fit engine to stand using engine mounting bracket 21–031

To Dismantle

1. Secure engine to stand by means of engine mounting bracket 21–031, Fig. 75.
2. Drain engine oil and remove oil filter, Fig. 76. Remove dipstick.
3. Remove clutch pressure plate (6 bolts) and clutch disc from flywheel.
4. Disconnect HT leads and remove distributor cap and leads. Remove spark plugs and distributor complete with vacuum line.

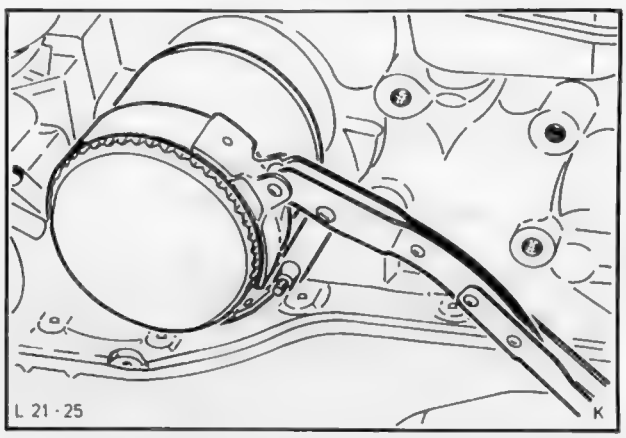


Fig. 76. Remove oil filter

5. Remove timing belt cover (3 bolts). Withdraw toothed belt guard to side of retaining bolt which also secures water pump, Fig. 77.

   Remove rocker cover.

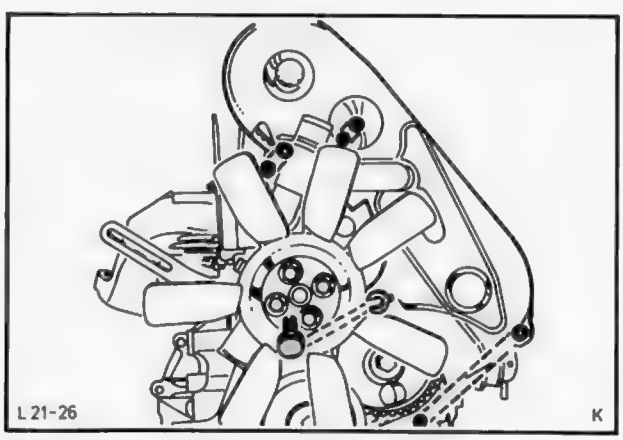


Fig. 77. Remove timing belt guard

6. Remove alternator with bracket (4 bolts).

   Take off V-belt and detach fan and pulley (4 bolts) from water pump.

7. Slacken crankshaft pulley (1 bolt) and remove together with thrust washer.

8. Remove auxiliary shaft bolt with toothed belt pulley.

9. Slacken toothed belt tensioner, using Special Tool 21–012 (1 bolt, 1 special bolt) press against spring pressure and retighten, Fig. 78.

   Remove toothed belt.

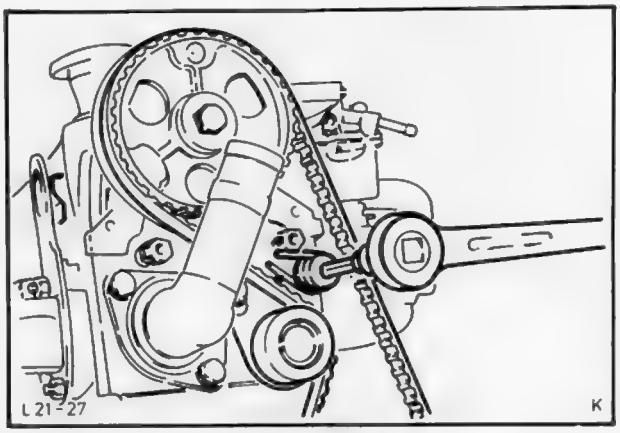


Fig. 78. Slacken toothed belt tensioner using Special Tool 21–012

10. Remove auxiliary shaft and crankshaft pulleys. On jammed crankshaft pulley use Special Tool 21-028, Fig. 79.

11. Remove fuel line from carburettor and withdraw breather hose with vent valve from oil separator.

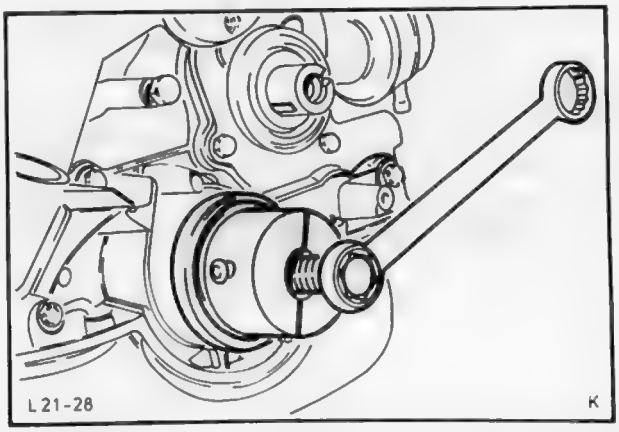


Fig. 79. Remove crankshaft pulley using Special Tool 21–028

12. Slacken cylinder head bolts (10) using Special Tool 21–002, Fig. 80. For unscrewing bolts reverse tightening sequence, Fig. 113. Remove bolts.

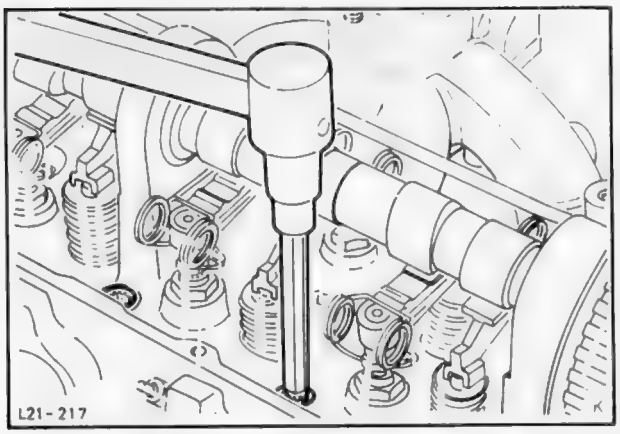


Fig. 80. Unscrew cylinder head bolts with Special Tool 21–002

13. Lift off cylinder head complete with inlet and exhaust manifolds. Remove water connection (2 bolts). Remove spacer and lift out thermostat together with gasket.
14. Detach fuel pump (2 bolts) and fuel line. Lift out tappet.
15. Remove oil pressure switch and prise oil separator out of engine block, using a screwdriver, Fig. 81.

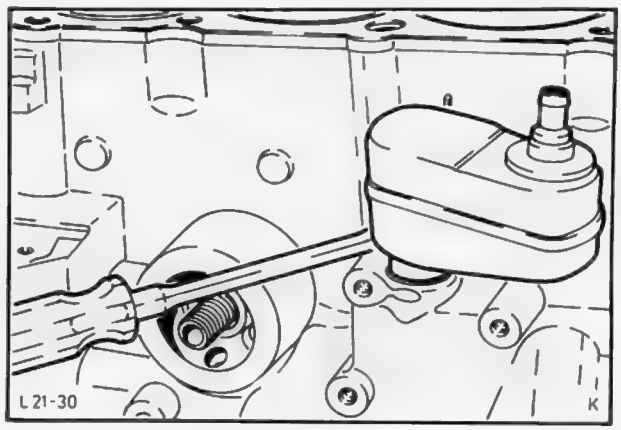


Fig. 81. Remove oil separator using a screwdriver

16. Remove sump with engine mounted upright in the stand, to prevent sludge and swarf from getting into engine, Fig. 82.
17. Remove auxiliary shaft front cover (3 bolts) and crankshaft front cover (4 bolts). Press oil seal out of both covers.
18. Remove retaining plate (2 bolts) and withdraw auxiliary shaft.

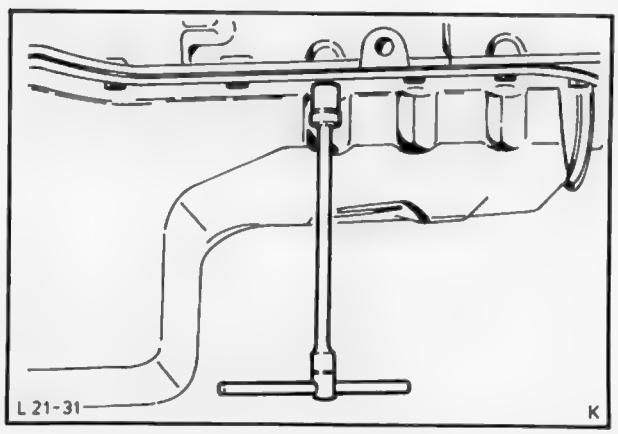


Fig. 82. Detach oil sump

19. Remove crankshaft needle roller bearing from crankshaft, using Special Tool 21–036, Fig. 83.

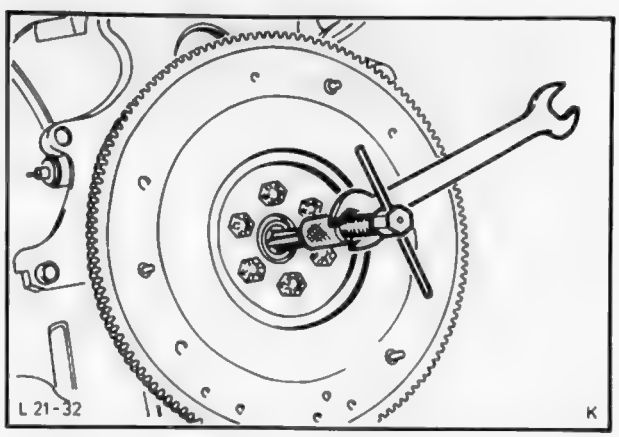


Fig. 83. Remove crankshaft needle bearing, using Special Tool 21–036

20. Set pistons at centre of their stroke and remove carbon deposits from cylinder head faces using a suitable scraper, Fig. 84, without touching piston bore.
21. Place a large tray under engine, invert engine and catch remaining oil, carbon remains and coolant.
22. Remove water pump (2 screws, 1 bolt).

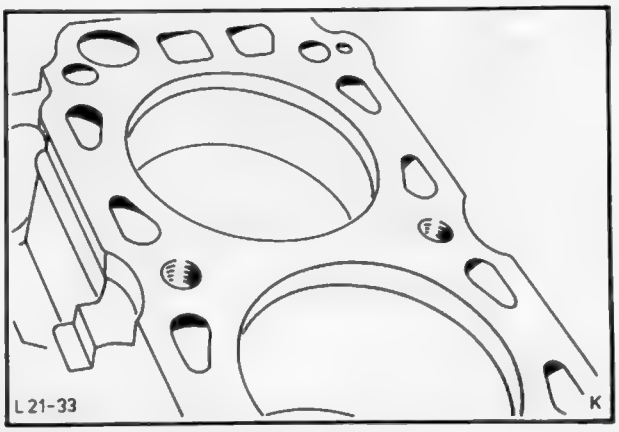


Fig. 84. Remove carbon deposits from cylinder head face

23. Remove oil pump (3 bolts) using Special Tool 21–012, Fig. 85, Lift out oil pump drive shaft.

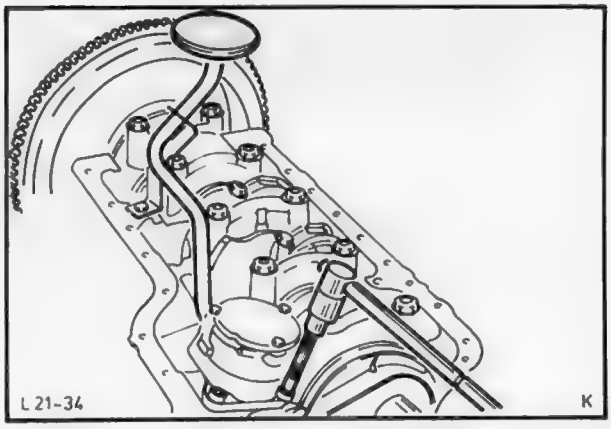


Fig. 85. Remove oil pump using Special Tool 21–012

24. Check markings on big end bearing caps and main bearing caps for subsequent reassembly, Fig. 86.

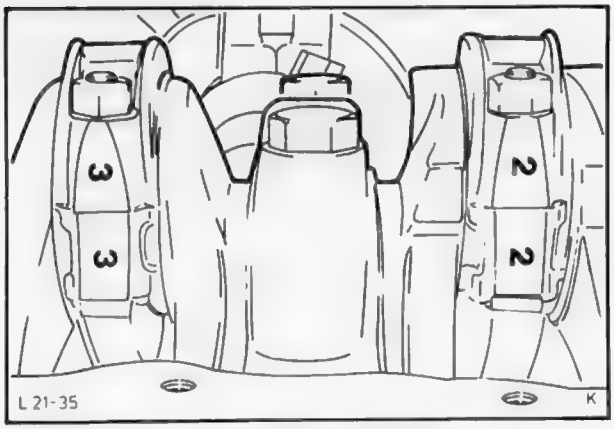


Fig. 86. Markings of big end and main bearing caps

25. Remove big end bearing caps one by one, together with bearing shells. Push pistons complete with connecting rods and bearing shells out of engine. If big end bearing shells are removed before pistons are taken out, mark shells to correspond with connecting rods, for purposes of subsequent reassembly.

26. Detach flywheel (6 bolts), Fig. 87.

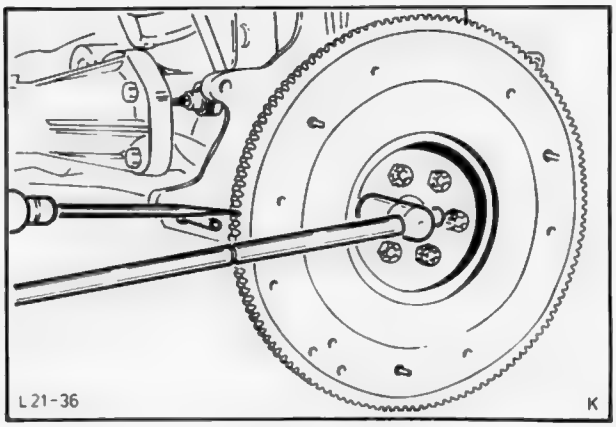


Fig. 87. Detach flywheel

27. Remove main bearing caps together with bearing shells. When removing centre main bearing cap, note position of two half thrust washers and mark them accordingly, Fig. 88.

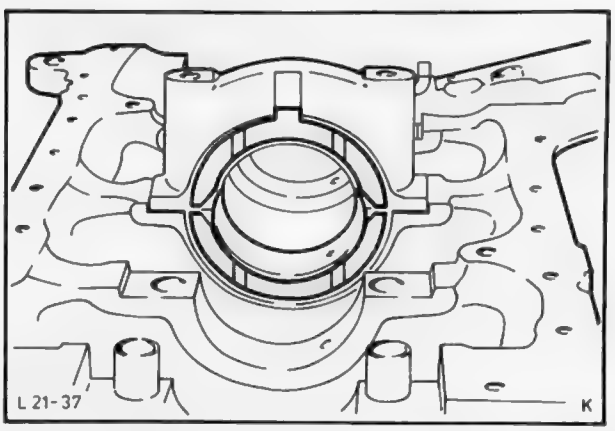


Fig. 88. Half thrust washers centre main bearing

28. Lift crankshaft out of cylinder block and remove rear oil seal, Fig. 89.

29. Remove bearing caps and half thrust washers from cylinder block and mark them for subsequent reassembly.

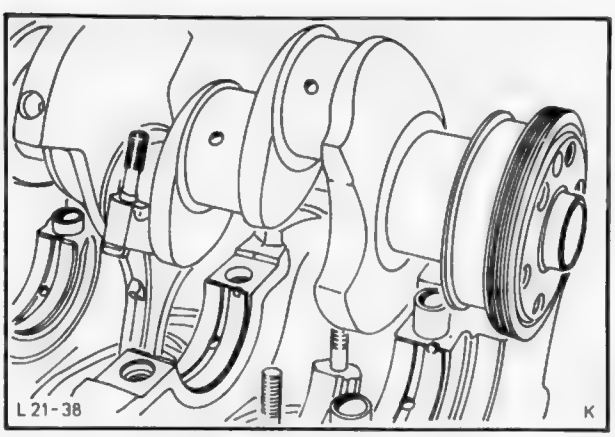


Fig. 89. Remove crankshaft

To Reassemble

The type and degree of cleaning of a given part before reasembly must depend on the hours the engine has run, the extent of any damage and its possible re-use. This applies particularly to the cylinder block with its corners, angles and bores. If necessary, remove all plugs and covers and clean their seats, using suitable cleaning agents and tools (brushes, scrapers). The oil galleries in particular, e.g. in the cylinder block, cylinder head, etc., should be free from dirt and abrasive particles, Fig. 90. If press-fit plugs and screw plugs are removed, they, like all seals and gaskets, should be renewed.

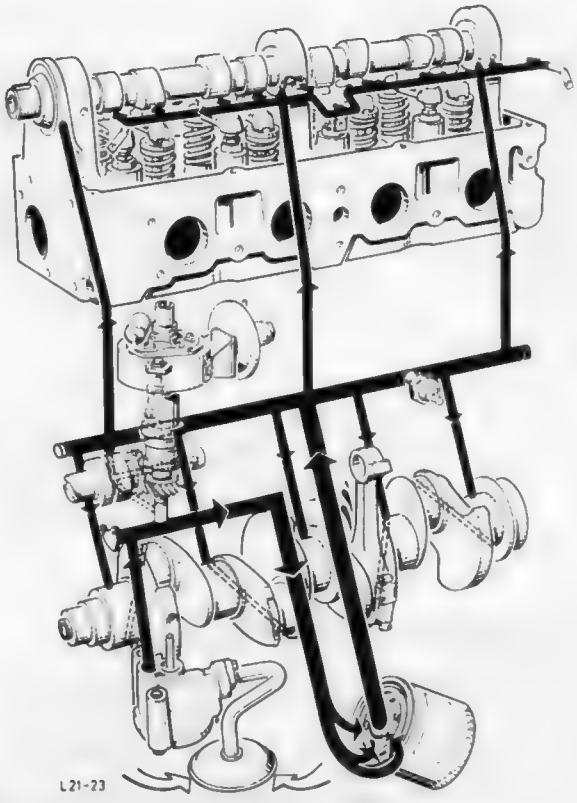


Fig. 90. Oil circuit

MAIN BEARINGS

Parent bore in cylinder block

The parent bore in the cylinder block may be either standard or 0,40 mm (0,015 in) oversize. There is no marking for the standard parent bore, but with an oversize bore the bearing caps are marked with white paint, Fig. 91.

Crankshaft main bearing journals

The crankshaft main bearing journals may be standard or (also in new engines) 0,25 mm (0,010 in) undersize. Standard main bearing journals are not marked, while the crankshaft web adjacent to an undersize main journal is marked with a green stripe.

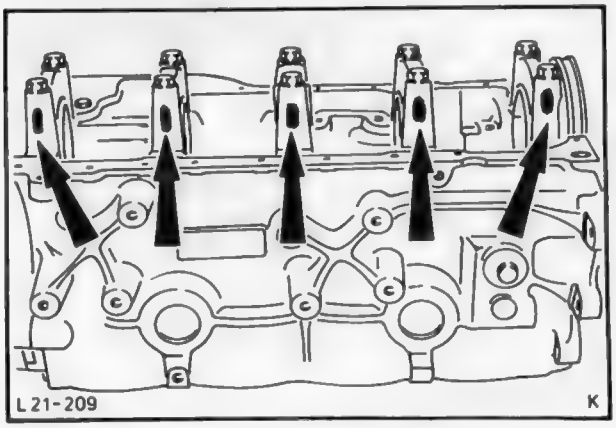


Fig. 91. Colour marking of main bearing caps

Crankshaft big end bearing journals

Standard big end bearing journals are not marked. Journals which are 0.25 mm (0,01 in) undersize are marked with a green paint spot on web next to the journal, Fig. 92.

Crankshafts with **undersize main and big end bearing journals** are marked with both stripe and spot on the front of the web adjacent to journals, Fig. 92.

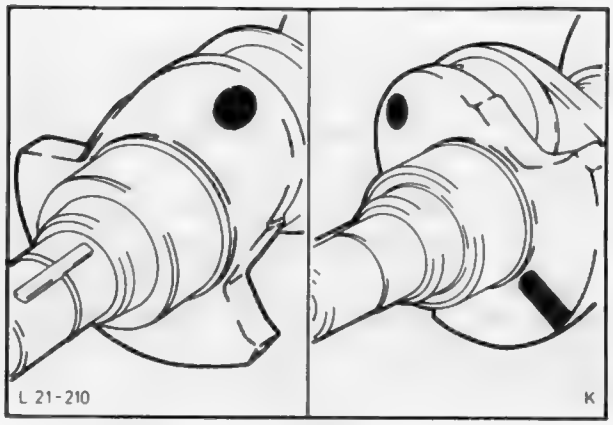


Fig. 92. Crankshaft colour markings

Connecting rods and bearing caps

The red mark on connecting rod and connecting rod cap is located on the side of the big end bearing boss, Fig. 93. Both colour marks must be on the same side in order to prevent faulty installation.

Standard main bearing and big end bearing shells are not marked. Bearing shells for undersize crankshafts or oversize cylinder blocks have an appropriate inscription on the back (see Parts Catalogue) while colour markings on production repair sizes are on the outer edge at the side, Fig. 94, with the exception of service main and big end bearing shells (0,5/0,75/ and 1,0 mm (0,02/0,03/0,04 in) undersize crankpins).

When new bearing shells are selected they should be checked against the Spare Parts Catalogue to ensure they are the appropriate ones and in addition they should be measured.

In order to remain within the specified tolerances (see Technical Data) journals, parent bores and bearing shells should be measured individually.

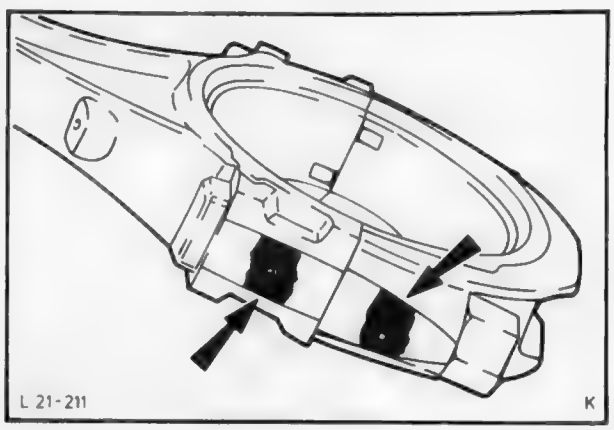


Fig. 93. Connecting rod colour markings

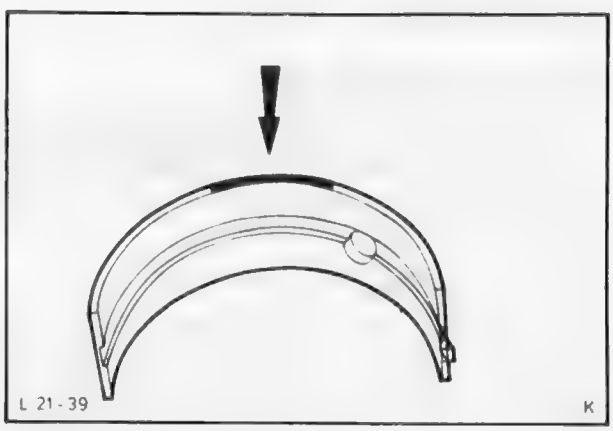


Fig. 94. Bearing shell colour marking

Measuring bearing clearance

Measuring bearings (even with undersize crankshafts) can be eliminated and determination of required bearing shells can be considerably simplified by use of:

'PLASTIGAGE' (type PG1) made by:

PERFECT CIRCLE CORPORATION,
HAGERSTOWN, INDIANA, USA.

UK Supplier:
NORMAN GAYDON (International)
68 London Road
Southend-on-Sea
Essex.

West German suppliers:
K. H. ERN/Motorenteile GmbH
Schinkelstrasse 46–48
D–4000 Dusseldorf.

'PLASTIGAGE' is the name of an accurately calibrated plastic filament.

Requirements for use of 'Plastigage'

1. Bearing should be dry and clean.
2. Crankshaft should not be turned during measuring operation.
3. Points of measurement should be close to top and bottom dead centre position.
4. Bearing caps should not be seated with hammer blows.

Procedure

Place length of Plastigage across width of bearing on crankshaft or big end journal, Fig. 95. Fit main or big end bearing cap together with bearing shells and torque as specified. The plastic filament will be compressed more or less depending on bearing clearance. Remove bearing cap.

Each main bearing should be measured separately without other bearing caps being fitted.

Width of compressed plastic filament can be measured by means of scale printed on PLASTIGAGE pack, Fig. 96, reading shows bearing clearance.

Only bolts in good condition should be used for securing bearing caps on crankshaft and they should not be tightened in excess of specified torque.

Measuring Piston Clearance

Procedure

1. When re-assembling an engine, the piston to bore clearance should be measured as follows.
2. The diameter of the piston should be measured when cold, using a micrometer. The measurement should be made across the piston skirt, at 90° to the piston pin axis.
3. The micrometer reading is then used to 'zero' a bore gauge. The reading on the dial of the bore gauge in situ is the piston to bore clearance (see Technical Data).

   Alternatively, the bore can be measured with an internal micrometer, and the piston size subtracted to give the piston to bore clearance.
4. The measurement must be taken below any visible wear marks in the bore. To detect bore ovality, two readings should be taken at 90° to each other.

   NOTE: The maximum difference between these two readings should not be more than 0,025 mm (0,001 in).
5. Inspect the bores for visible wear, damaged lips etc.
6. If the clearance in sub-section 3 above is excessive, or if ovality, or any of the faults in sub-section 5 above is detected, the block should be rebored to suit oversize pistons.
7. Before installing pistons, check piston ring gaps.

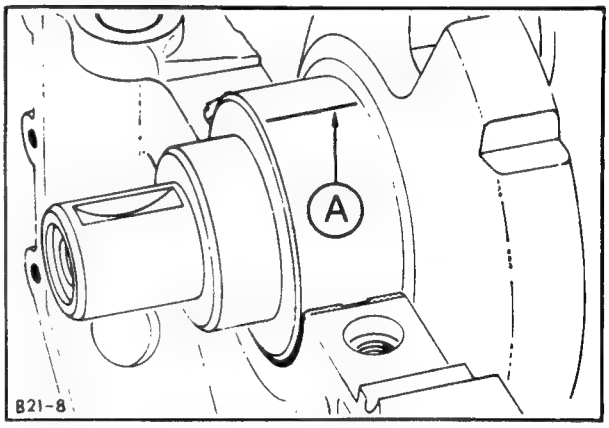


Fig. 95. Location of Plastigage thread
A – Calibrated plastic thread

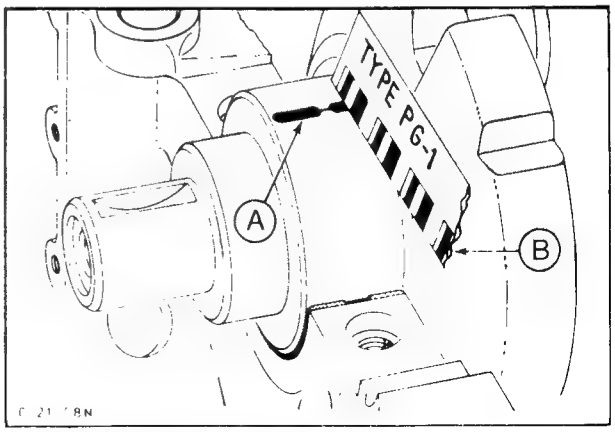


Fig. 96. Measuring bearing play
A – Compressed plastic thread
B Measurement scale

30. Press new pilot bearing into crankshaft, using Special Tool 21–044, Fig. 97.

31. Insert main bearing shells dry into cylinder block, apply engine oil and place crankshaft in position.

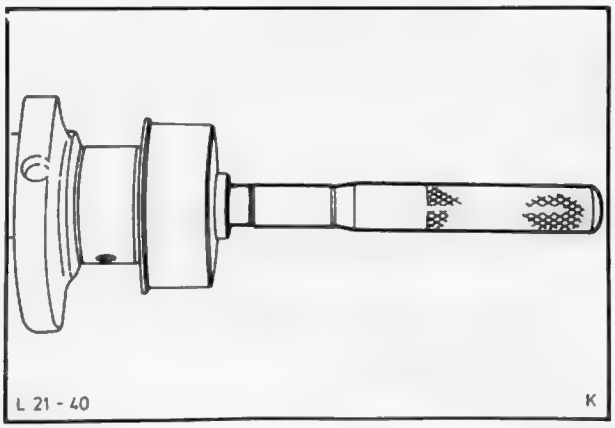


Fig. 97. Fitting crankshaft pilot bearing using Special Tool 21–044

32. Apply thin coat of sealing compound (Part No. A 70SX-19554-BA) to main bearing cap contact faces, Fig. 98, position main bearing caps complete with oiled bearing shells, rear main bearing cap on rear of contact face. Ensure thrust rings are fitted to centre bearing.

Arrows on main bearing caps should point to front of engine.

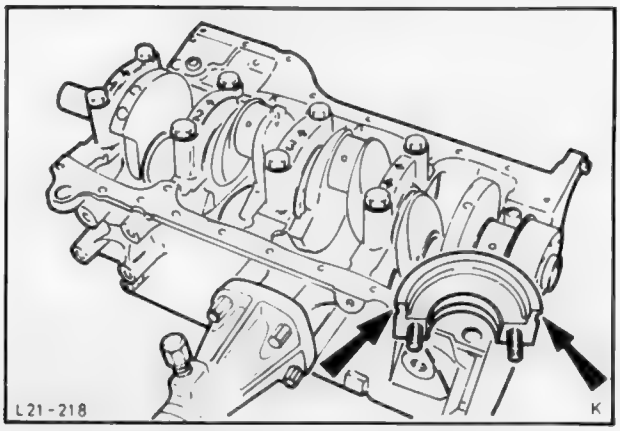


Fig. 98. Apply sealing compound to main bearing cap contact face

33. Tighten bearing cap bolts uniformly to torque specified in Technical Data. On this engine two guide bushes each are provided for securing rear and centre main bearing caps, Fig. 99.

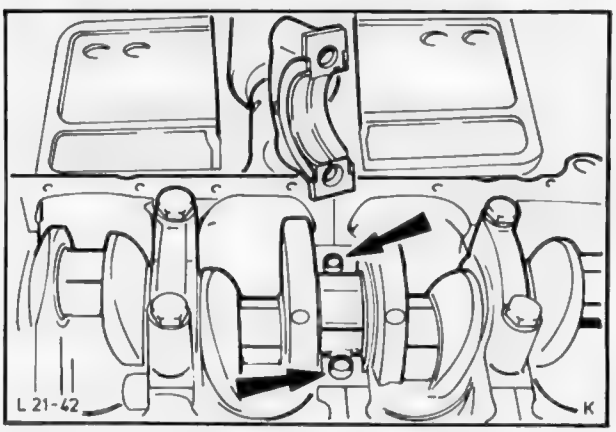


Fig. 99. Centre main bearing bushes

34. Check crankshaft end-float with a standard dial indicator, Fig. 100, and correct using thrust washers (see Technical Data).

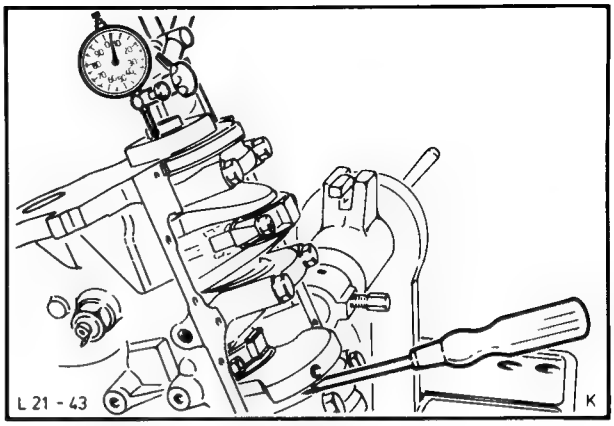


Fig. 100. Check crankshaft end-float

35. Moisten sealing lip of new rear oil seal. Slide new oil seal onto Special Tool 21–011–A and press firmly against rear main bearing, Fig. 101.

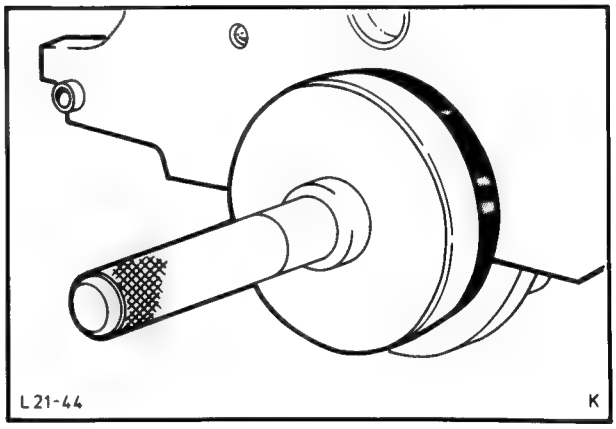


Fig. 101. Fit rear oil seal using Special Tool 21–011–A

36. Coat rear main bearing cap inserts with sealing compound (Part No. A 70SX-19554-BA) and press in, using a **blunt** screwdriver, Fig. 102. Rounded face of dowel bush has red mark and should be fitted pointing towards bearing cap.

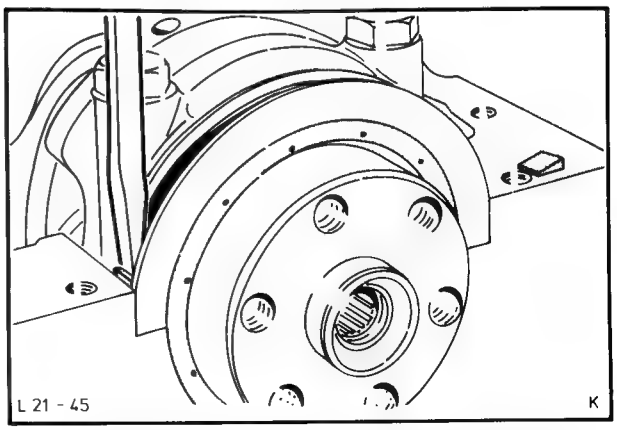


Fig. 102. Press in rear main bearing cap inserts, using **blunt** screwdriver

37. Align crankshaft timing cover with new oil seal and new gasket on sump mating surface, using Special Tool 21–009–A, Fig. 103, to avoid damage to sealing lip. Torque timing cover as specified in Technical Data.

38. Install auxiliary shaft and fit thrust plate. Fit front cover with new oil seal, sealing lip slightly lubricated, using Special Tool 21–009–A to avoid damage to sealing lip.

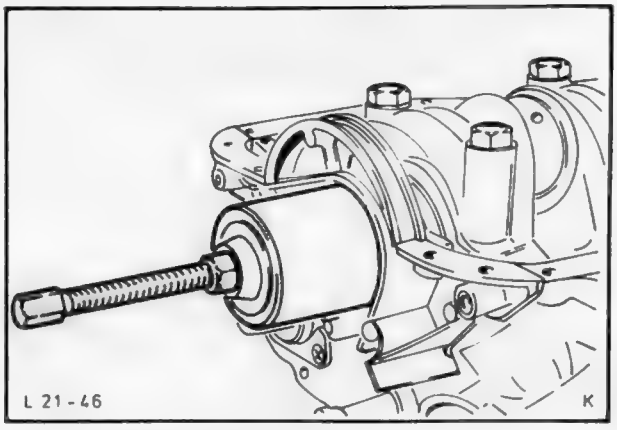


Fig. 103. Centre timing cover, using Special Tool 21–009–A

39. Fit flywheel, Fig. 104, and torque as specified in Technical Data.

Re-use only bolts which are in good condition and lubricated.

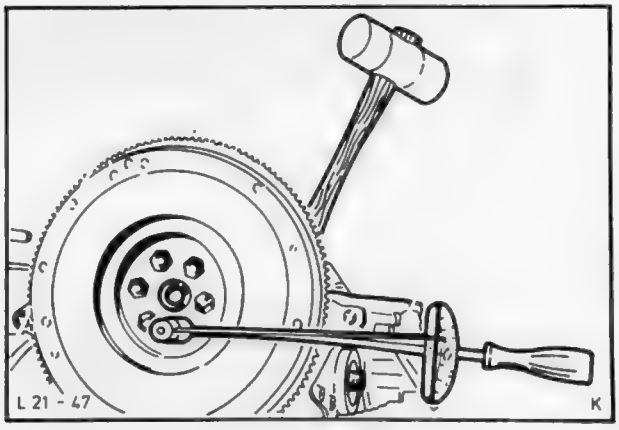


Fig. 104. Fit flywheel

40. Centre clutch disc, using Special Tool 21–044, Fig. 105. Place pressure plate on dowels and torque as specified in Technical Data.

41. Invert engine. Apply engine oil to pistons and cylinder bores. Stagger piston rings to specified gaps, refer to Technical Data.

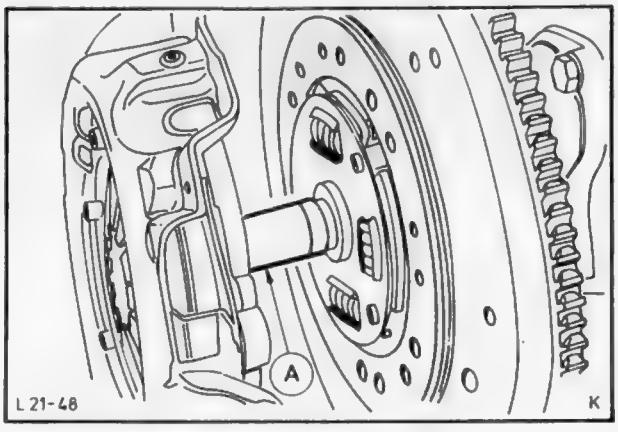


Fig. 105. Centre clutch disc using
A – Special Tool 21–044

42. Compress piston rings with a standard tool (ring compressor), Fig. 106. Slide piston into cylinder using a hammer handle, guiding connecting rod on to big end journal by hand. **The 'front' marking on piston (arrow, notches, etc.)** should point to front of engine.

43. Invert engine.

    Place big end bearing shell in position, apply oil and press connecting rod firmly against big end bearing journal.

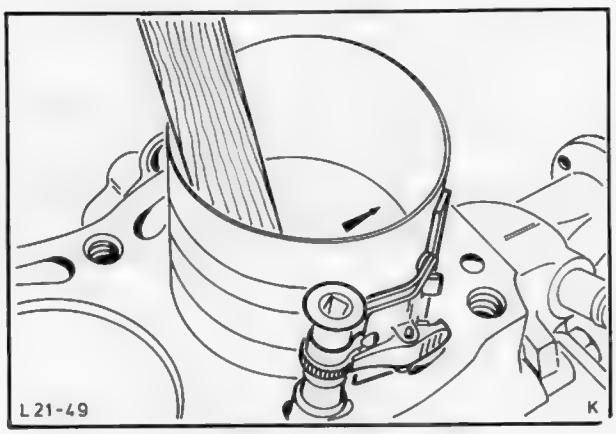


Fig. 106. Fit piston using a ring compressor

44. Fit big end bearing cap complete with oiled bearing shell. Torque connecting rod bolts as specified in Technical Data, Fig. 107.

    Check whether connecting rods have enough endfloat on journals.

45. Fit oil pump drive shaft. Place oil pump complete with suction pipe on centring bush and torque as specified in Technical Data.

    When a new or overhauled oil pump is used, it should be turned by hand through a complete rotation and filled with engine oil prior to installation.

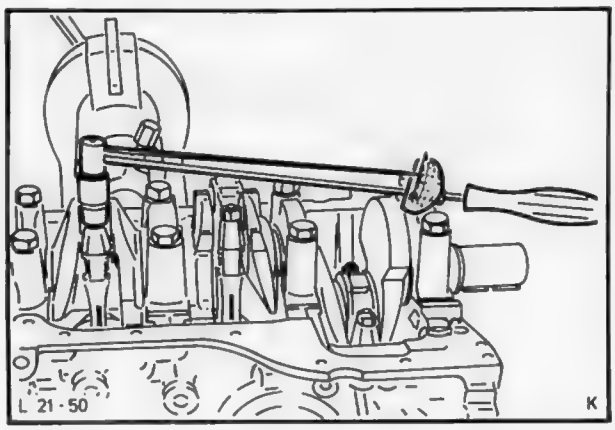


Fig. 107. Torque connecting rod bolts as specified in Technical Data

46. Insert rubber seal in groove of rear seal carrier. Apply sealing compound to cylinder block mating surface at joint of cover and rear seal carrier. Place sump gasket in position and slide projections on cork gasket under cut-outs in rubber gasket, Fig. 108.

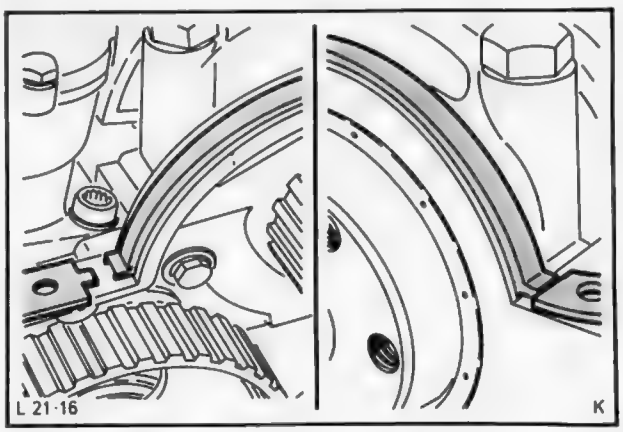


Fig. 108. Fit oil sump gasket

47. Place sump in position, Fig. 109, and torque bolts, as specified, in three stages as follows:

1st stage commencing with bolt 'A'
1 to 2 Nm (0,1 to 0,2 kgf.m) (1 lbf.ft)
2nd stage commencing with bolt 'B'
6 to 8 Nm (0,6 to 0,8 Kgf.m) (5 lbf.ft)
3rd stage, after running engine 20 minutes, commencing with bolt 'A'
8 to 10 Nm (0,8 to 1,0 kgf.m) (7 lbf.ft).

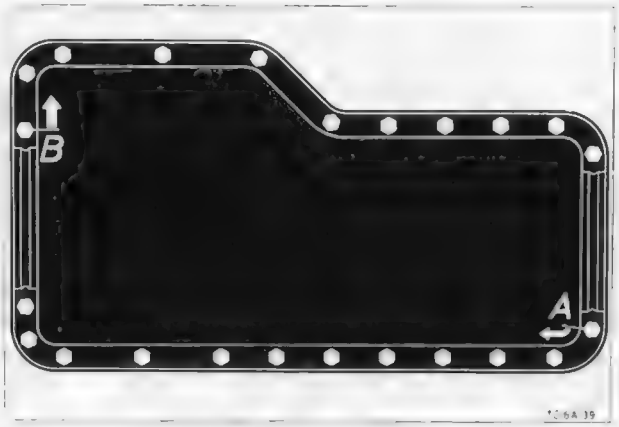


Fig. 109. Sump bolt tightening sequence

48. Insert fuel pump tappet in bore and fit fuel pump, Fig. 110.

49. Invert engine. Apply metal jointing compound (Loctite) to oil separator and press up to stop in cylinder block.

50. Fit water pump with gasket, in doing so, tighten bolt of alternator bracket finger-tight.

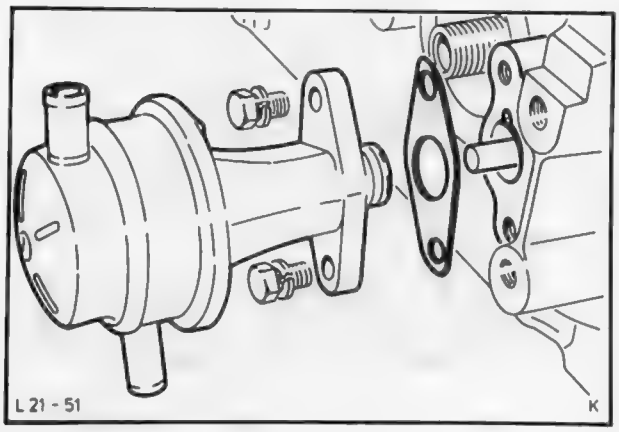


Fig. 110. Fit fuel pump

51. Screw in oil filter cartridge until rubber gasket makes contact with housing, then tighten a further $\frac{3}{4}$ turn, Fig. 111. **Apply engine oil to rubber gasket before fitting.**

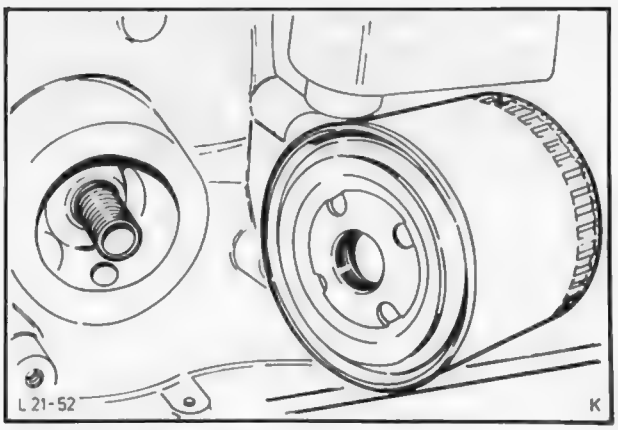


Fig. 111. Fit oil filter cartridge

52. Fit oil pressure switch and torque as specified in Technical Data.

53. Fit auxiliary shaft toothed belt pulley with reinforced side facing inwards. Attach crankshaft toothed belt pulley (with chamfered side inwards) with thrust washer and belt pulley.

The thrust washer is dished and must be fitted with the concave side facing the toothed pulley.

54. Screw in Special Tool 21–003, as shown in Fig. 112, in place of cylinder head bolts 7 and 9, Fig. 113, and fit head gasket.

To avoid damage to valves and pistons, crankshaft must be turned before fitting cylinder head so that piston of 1st cylinder is some 2 cm before TDC.

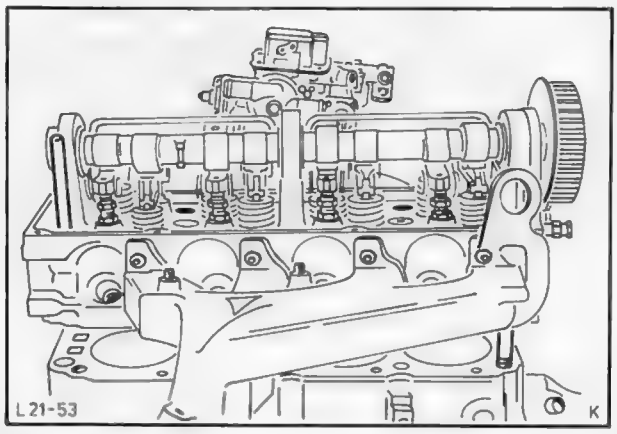


Fig. 112. Fit cylinder head with aid of locating studs 21–003

55. Fit cylinder head, Fig. 112, and insert bolts finger-tight. Replace the two locating studs with the two remaining bolts. Torque cylinder head bolts as specified using Special Tool 21–002 in three stages proceeding in the sequence shown in Fig. 113.

1st stage: 40–55 Nm (4,0–5,5 kgf.m) (35 lbf.ft)
2nd stage: 50–70 Nm (5,0–7,0 kgf.m) (44 lbf.ft)
10–20 minutes later: 85–95 Nm (8,5–9,5 kgf.m) (66 lbf.ft)

When the engine is fitted in the vehicle, retighten cylinder head bolts as indicated in stage 4 (see Technical Data).

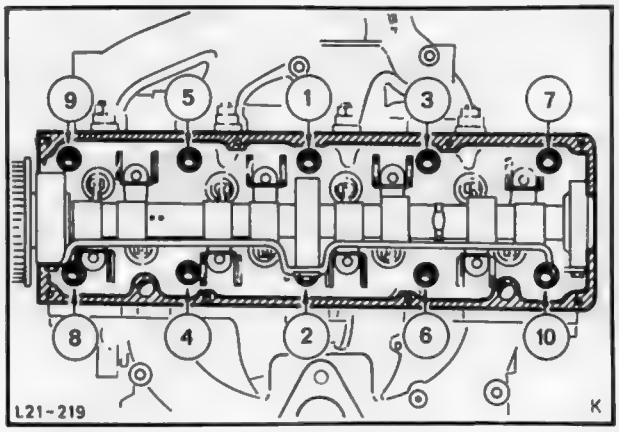


Fig. 113. Cylinder head bolt tightening sequence

Before fitting toothed belt, first turn camshaft toothed belt pulley to TDC mark on cylinder head, Fig. 114. Then turn crankshaft belt pulley to TDC mark by the shortest route.

Fig. 114. Camshaft toothed belt pulley on TDC mark

56. Fit toothed belt. Slacken toothed belt tensioner so that it can rest against the toothed belt after twice cranking engine. After cranking tighten toothed belt tensioner to specified torque, hexagon bolt first, then special bolt, Fig. 115.

After positioning of toothed belt crank engine in direction of normal rotation only.

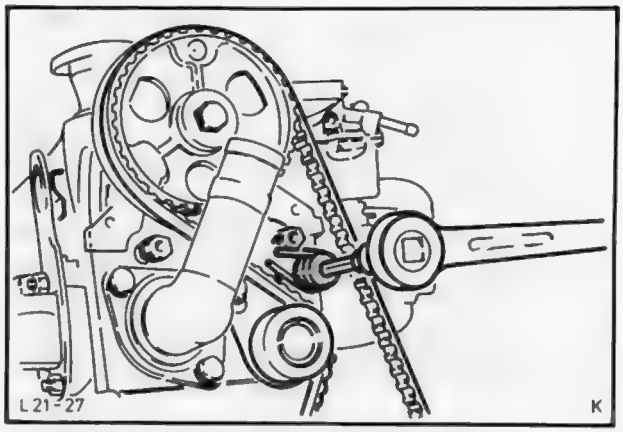


Fig. 115. Tighten belt tensioner

57. Slide thrust washer and crankshaft pulley into position. Torque crankshaft pulley and auxiliary shaft toothed belt pulley as specified in Technical Data. Fit toothed belt guard, Fig. 116.

Thrust washer is cup-shaped and should be fitted with hollow side facing gear.

58. Fit alternator and bracket. Fit fan complete with pulley to water pump.

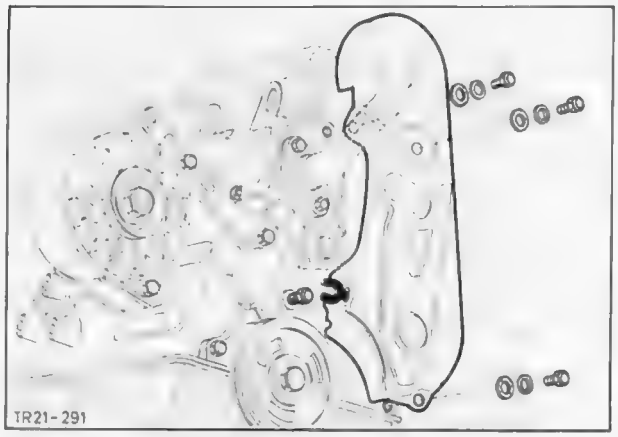


Fig. 116. Fit toothed belt guard

59. Fit fan belt and adjust belt tension to achieve 13 mm (0,5 in) free movement midway between alternator and fan pulleys, Fig. 117.

60. Crank engine to bring cylinder No. 1 to TDC and install distributor so that rotor arm is also at mark for No. 1 cylinder.

61. Connect vacuum line and fuel line to carburettor.

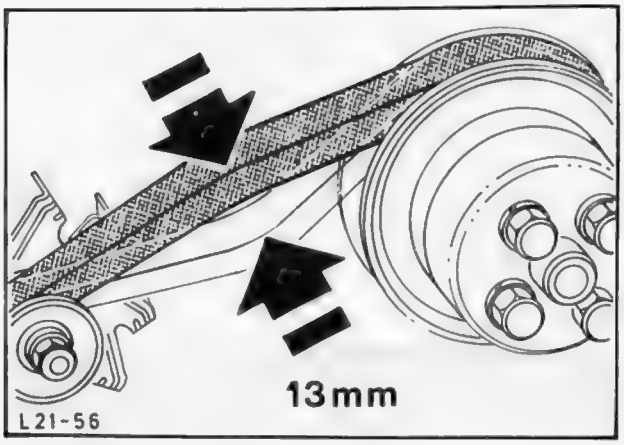


Fig. 117. Tighten fan belt

62. Check valve clearances and adjust, if necessary (see Operation No. 21 213 'B' engine), Fig. 118.

63. Fit rocker cover, ensuring correct engagement of gasket projection.

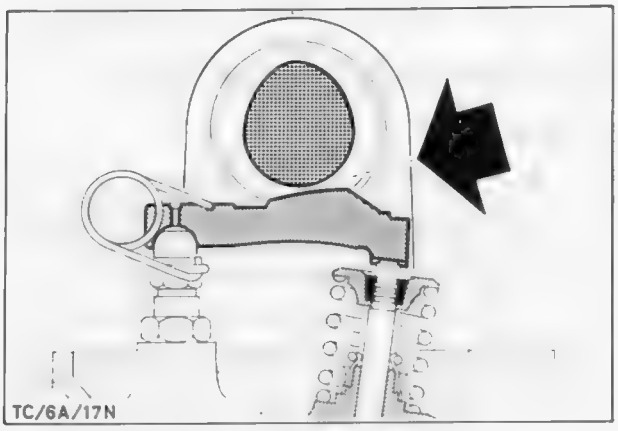


Fig. 118. Adjust valve clearances

64. Torque rocker cover bolts as specified in four stages, proceeding in sequence specified, Fig. 119.

1st stage, tighten bolts 1–6
5 to 7 Nm (0,5 to 0,7 kgf.m) (4,4 lbf.ft)
2nd stage, tighten bolts 7 and 8
2 to 2,5 Nm (0,2 to 0,25 kgf.m) (1,7 lbf.ft)
3rd stage, tighten bolts 9 and 10
5 to 7 Nm (0,5 to 0,7 kgf.m) (4,4 lbf.ft)
4th stage, tighten bolts 7 and 8
5 to 7 Nm (0,5 to 0,7 kgf.m) (4,4 lbf.ft)

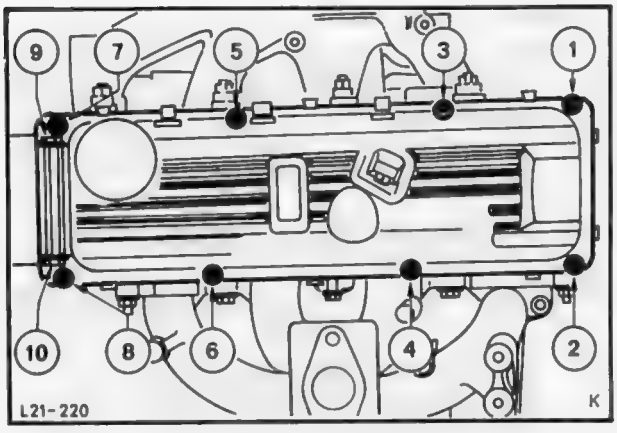


Fig. 119. Rocker cover bolt tightening sequence

65. Fit spark plugs and torque as specified in Technical Data. Refit distributor cap and connect HT leads to spark plugs as shown in Fig. 120.

66. Fit oil drain plug complete with new washer and torque as specified in Technical Data.

Every time oil is changed and oil drain plug is removed a new washer should be fitted.

67. Fit breather hose together with vent valve in oil separator.

68. Insert dipstick and remove engine from stand.

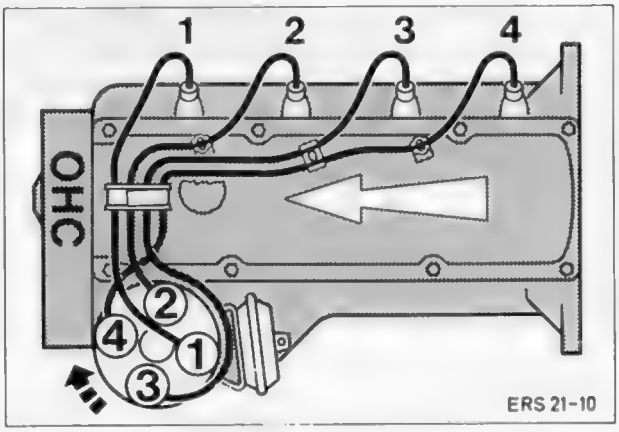


Fig. 120. Arrangement of HT leads (firing order)

21 163 CYLINDER HEAD – REMOVE AND INSTALL

Special Service Tool Required:

Cylinder head bolt wrench 21–034

To Remove

1. Disconnect battery earth strap, drain coolant into tray by disconnecting radiator hose from radiator bottom neck and engine water outlet at top, Fig. 124.

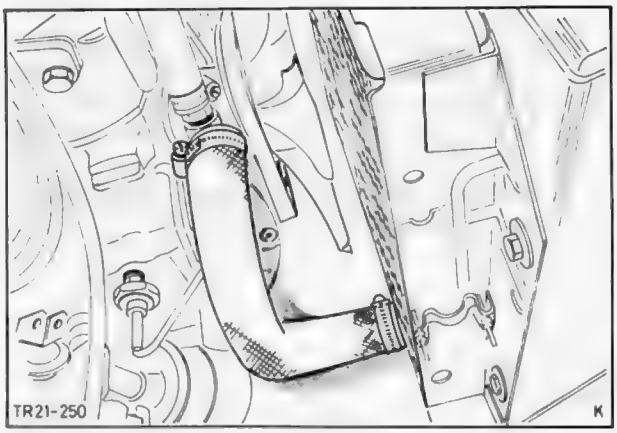


Fig. 124. Disconnect radiator hose from radiator

2. Remove air cleaner and disconnect fuel line from carburettor and engine breather hose from oil separator. Remove brake servo vacuum hose from inlet connector.
3. Detach throttle cable with bracket from inlet manifold (2 bolts) and disconnect throttle linkage at carburettor, Fig. 125. Unscrew choke cable at carburettor.

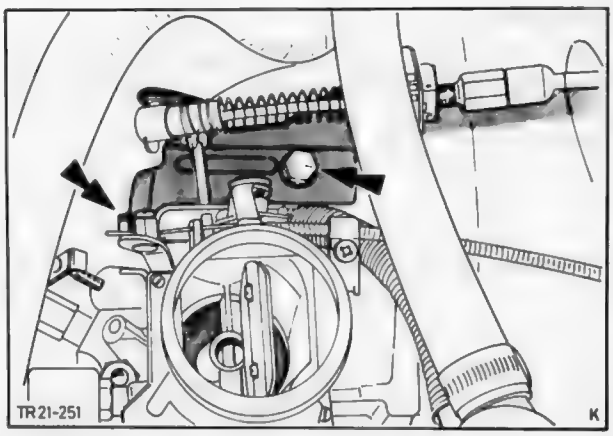


Fig. 125. Unhook throttle cable at throttle linkage and remove with bracket

4. Detach vacuum line from carburettor and disconnect hot water hose from inlet manifold.
5. Disconnect lead from idling cut-off valve temperature sender unit and HT leads from spark plugs and ignition coil. Remove distributor cap and distributor rotor arm.
6. Detach cylinder head water elbow (2 bolts) and remove thermostat, Fig. 126. Disconnect exhaust pipe from exhaust manifold (2 nuts).

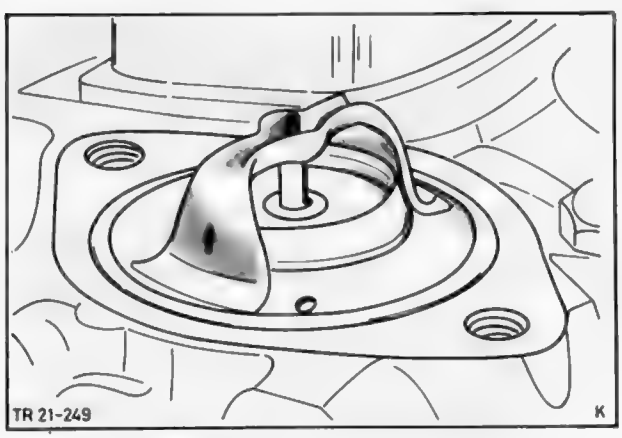


Fig. 126. Remove thermostat

21 163 (cont'd)

7. Remove spark plugs, rocker cover and rocker shaft (4 bolts each), Fig. 127. Take out push rods and remove cylinder head bolts, slackening bolts in reverse order to tightening (see tightening sequence in Fig. 129). Detach cylinder head.

   Do not interchange push rods when removing and re-installing.

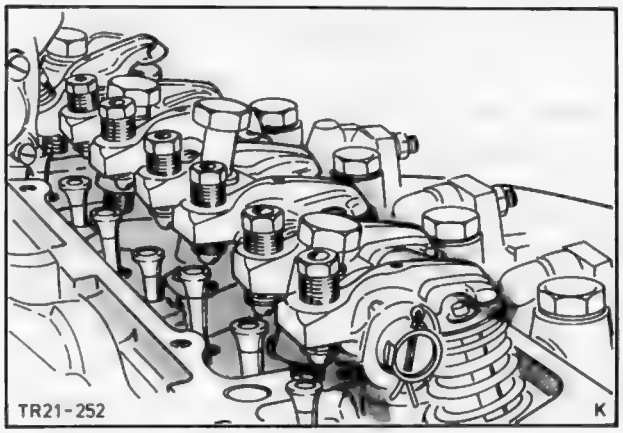


Fig. 127. Remove rocker shaft

To Install

8. After cleaning mating faces (cylinder head and cylinder block), fit new cylinder head gasket.

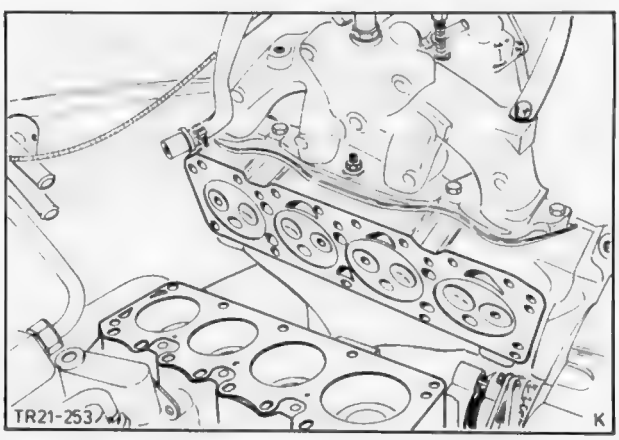


Fig. 128. Replace cylinder head

9. Fit cylinder head, Fig. 128. Insert cylinder head bolts finger tight. Take out locating studs and replace them by the last two bolts. Cylinder head bolts should then be tightened to specified torque in four stages in order shown in Fig. 129, using Special Tool 21–034.

   1st stage 40 to 55 Nm (4,0 to 5,5 kgf.m) (35 lbf.ft)
   2nd stage 50 to 70 Nm (5,0 to 7,0 kgf.m) (44 lbf.ft)
   10 to 20 minutes later
   85 to 95 Nm (8,5 to 9,5 kgf.m) (66 lbf.ft)
   When the engine is fitted to the vehicle retighten cylinder bolts as indicated in stage 4 (see Technical Data)

   Bolts are of different lengths to suit different thicknesses of cylinder head.

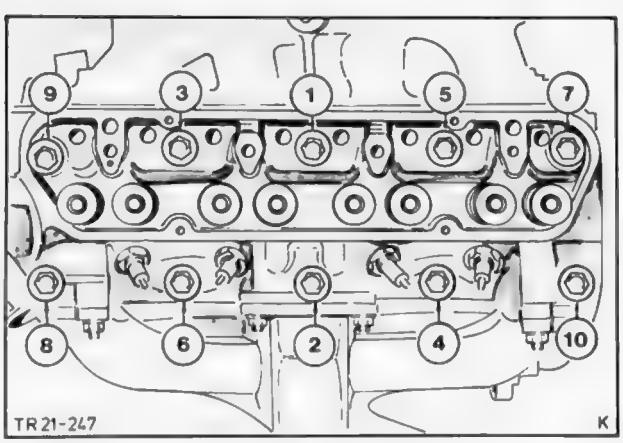


Fig. 129. Cylinder head bolts, tightening sequence

10. Lubricate both ends of push rods and place them in push rod sockets. Fit rocker shaft, guiding rocker arm adjusting screws into push rod sockets. Insert rocker shaft bolts and torque them as specified in Technical Data, Fig. 130.

11. Adjust valve clearances (see Operation No. 21 213, 'A' engine). Fit spark plugs and rocker cover.

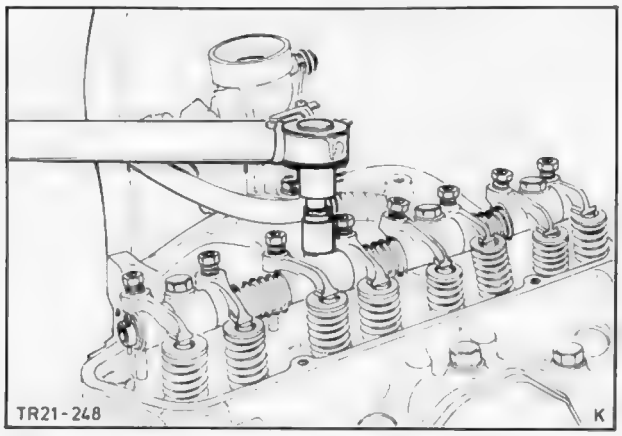


Fig. 130. Torque rocker shaft bolts as specified in Technical Data

12. Insert thermostat, locate gasket and attach water outlet connection with air cleaner bracket. Attach exhaust pipe to exhaust manifold.

13. Connect leads to idling cut-off valve, temperature sender unit and attach HT leads to sparking plugs and coil. Fit distributor rotor arm and cap.

14. Connect vacuum line to carburettor and attach hot water hose to inlet manifold.

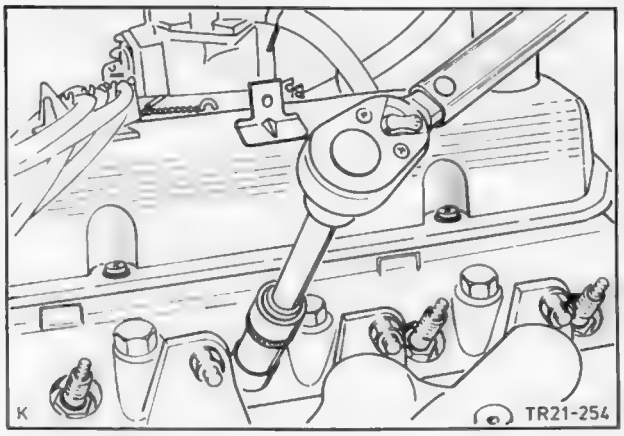


Fig. 131. Secure spark plugs with standard plug socket

15. Assemble throttle cable with bracket, hook up to throttle linkage, Fig. 132, and adjust. Attach choke cable, if fitted, and adjust.

16. Secure brake servo vacuum line to inlet connector. Connect engine breather hose to oil separator and fuel line to carburettor.

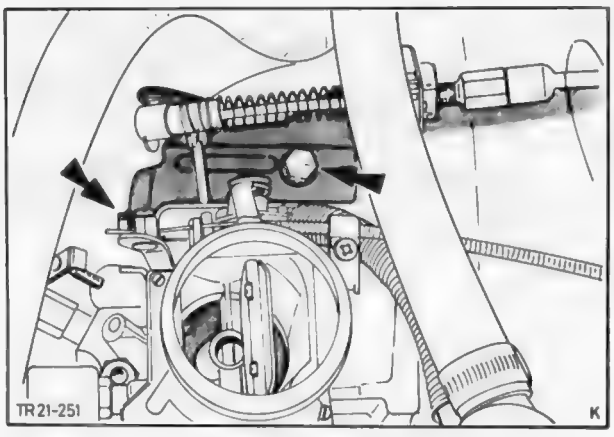


Fig. 132. Hook throttle cable to throttle linkage and secure bracket

21 163 (cont'd) **ENGINE 'A'**

17. Connect radiator hoses, Fig. 133, and top up with coolant. Connect earth strap to battery.
18. Allow engine to warm up for 15 mins. at 1000 rev/min, adjust dwell angle, timing, idling speed and CO content.

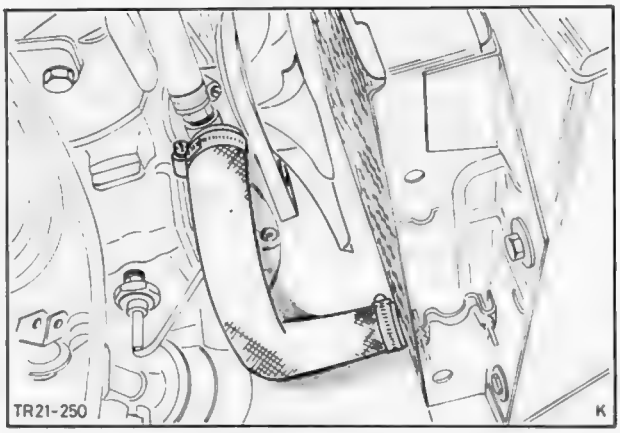


Fig. 133. Connect hose to radiator

19. After adjustments have been carried out with engine warmed up, disconnect HT leads from spark plugs and remove rocker cover.

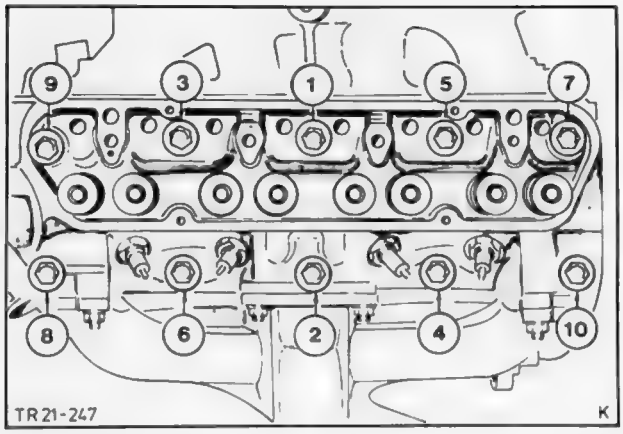


Fig. 134. Cylinder head bolt tightening sequence

20. Retighten cylinder head bolts to specified torque in the sequence shown in Fig. 134, using Special Tool No. 21–034. Retighten bolts securing rocker shaft and recheck valve clearances.
21. Refit rocker cover tightening bolts to specified torque, fit HT leads, Fig. 135, and refit air cleaner.

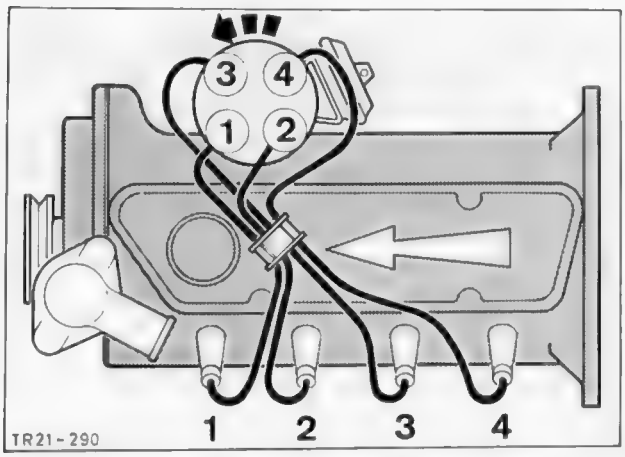


Fig. 135. Spark plug HT lead arrangement (firing order)

21 163 CYLINDER HEAD – REMOVE AND INSTALL (ONE)

Special Service Tools Required:

Cylinder head bolt wrench	21–002
Cylinder head alignment studs	21–003
Valve adjustment locknut wrench	21–004–A
Oil pump bolt and drive belt tensioner socket	21–012

To Remove

1. Disconnect battery earth strap and remove engine splash shield (5 screws), Fig. 136 Drain coolant into tray by disconnecting radiator hose from radiator bottom neck and engine water outlet at top.
2. Remove air cleaner and disconnect fuel line(s) from carburettor and engine breather hose from oil separator.
3. Disconnect brake servo vacuum hose from inlet manifold connection. Unhook throttle cable at throttle linkage and remove with bracket, Fig. 137.
4. Disconnect lead from temperature sender unit and HT leads from spark plugs and ignition coil. Remove distributor cap and distributor rotor arm.
5. Remove vacuum hose from carburettor, disconnect heater hose from automatic choke and exhaust pipe from exhaust manifold (2 nuts).

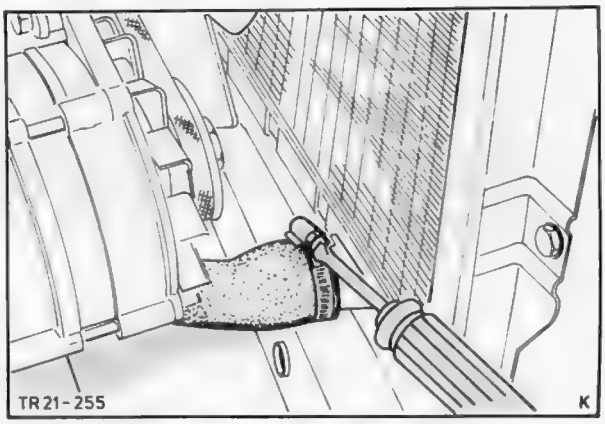


Fig. 136. Remove radiator hose from radiator

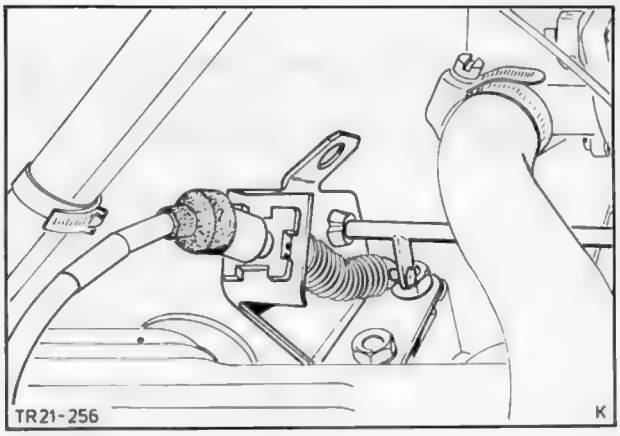


Fig. 137. Unhook throttle cable and remove with bracket

6. Remove toothed belt guard (3 bolts) and rocker cover (10 bolts). Slacken toothed belt tensioner using Special Tool 21–012 (1 hexagon bolt, 1 special bolt) Fig. 138, press against spring pressure and retighten. Remove toothed belt from camshaft toothed belt pulley.

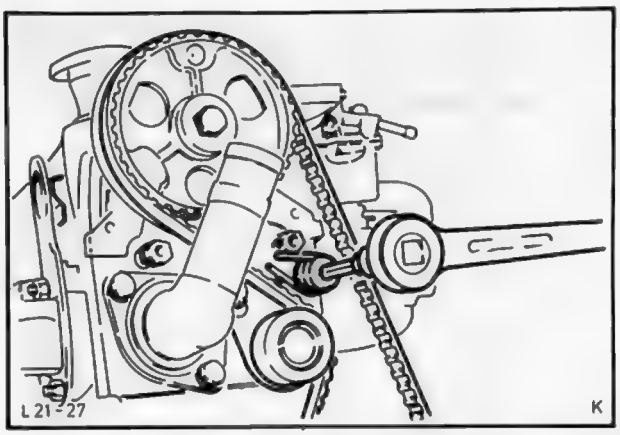


Fig. 138. Slacken toothed belt tensioner using Special Tool 21–012

7. Remove spark plugs and detach cylinder head (10 bolts) using Special Tool 21–002, Fig. 139. When unscrewing cylinder head bolts reverse tightening sequence (see Fig. 141).

After complete removal cylinder head should not be placed on mating surface because of possible damage to valves in fully open position.

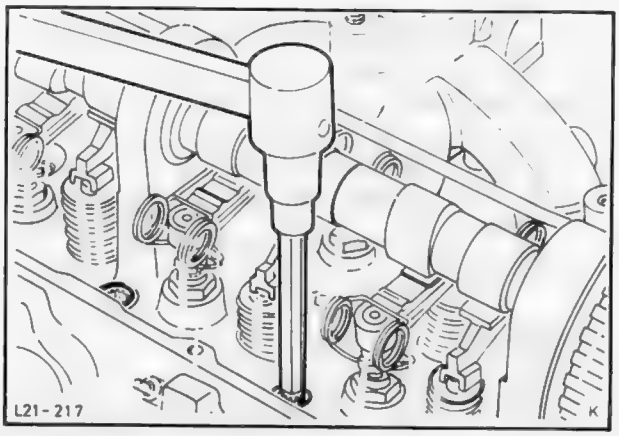


Fig. 139. Remove cylinder head using Special Tool 21–002

To Install

8. After cleaning mating faces (cylinder head –cylinder block), screw cylinder head alignment studs 21–003 into cylinder block and fit new cylinder head gasket.

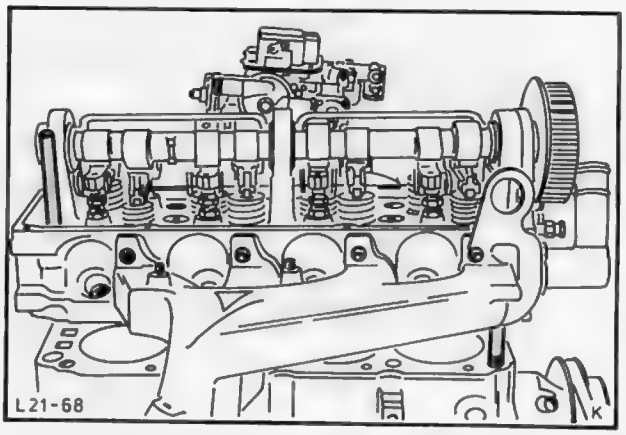


Fig. 140. Fit cylinder head using centering studs 21–003

To avoid damage to valves and pistons, the crankshaft must be turned before the cylinder head is fitted so that piston of 1st cylinder is about 2 cm before TDC.

9. Fit cylinder head, Fig. 140, and insert cylinder head bolts finger tight. Take out locating studs and replace them by the last two bolts. Cylinder head bolts should then be tightened to specified torque in three stages in order shown in Fig. 141.

1st stage	40 to 55 Nm (4,0 to 5,5 kgf.m) (35 lbf.ft)
2nd stage	50 to 70 Nm (5,0 to 7,0 kgf.m) (44 lbf.ft)

10 to 20 minutes later
85 to 95 Nm (8,5 to 9,5 kgf.m) (66 lbf.ft)

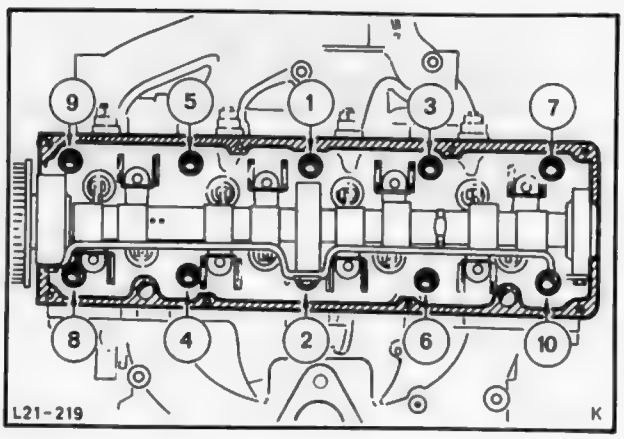


Fig. 141. Cylinder head bolt tightening sequence

Before fitting toothed belt, first turn camshaft toothed belt pulley to TDC mark on cylinder head. Then turn crankshaft belt pulley to TDC mark by taking shortest route, and set distributor rotor arm to mark for 1st cylinder, Fig. 142.

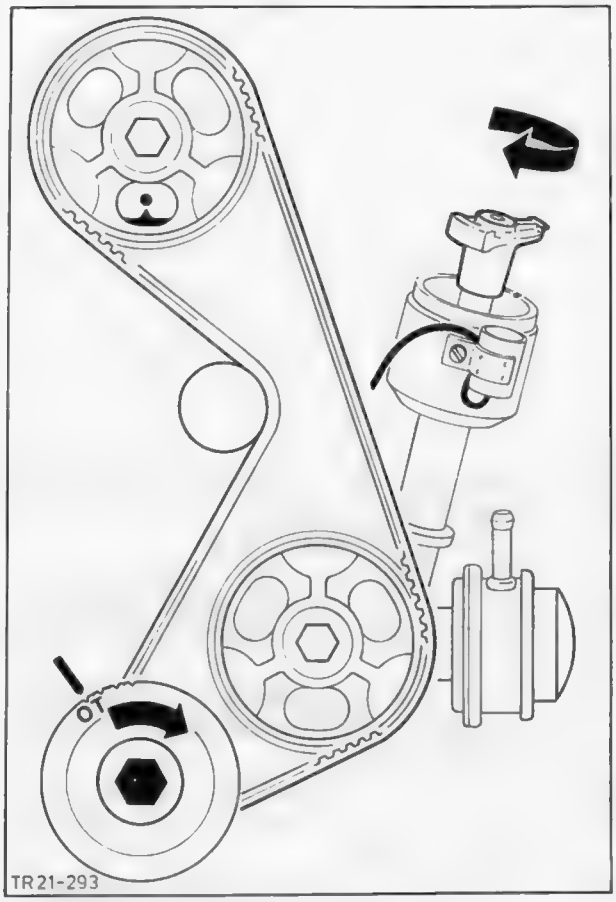


Fig. 142. Piston of No. 1 cylinder at TDC

10. Fit toothed belt. Slacken belt tensioner so that it will rest against the toothed belt when the engine is cranked over twice. After cranking, torque belt tensioner as specified in Technical Data.

After positioning toothed belt crank engine in direction of rotation only.

11. Check valve clearances, and adjust if necessary, using Special Tool 21–004–A (see Operation No. 21 213, 'B' engine).

12. Fit rocker cover ensuring that gasket dovetail engages correctly.

13. Tighten rocker cover bolts to prescribed torque (see Technical Data) as shown in Fig. 143, in the following four stages.

1st stage, tighten bolts 1 to 6
5 to 7 Nm (0,5 to 0,7 kgf.m) (4,4 lbf.ft)
2nd stage, tighten bolts 7 and 8
2 to 2,5 Nm (0,2 to 0,25 kgf.m) (1,7 lbf.ft)
3rd stage, tighten bolts 9 and 10
5 to 7 Nm (0,5 to 0,7 kgf.m) (4,4 lbf.ft)
4th stage, tighten bolts 7 and 8
5 to 7 Nm (0,5 to 0,7 kgf.m) (4,4 lbf.ft)

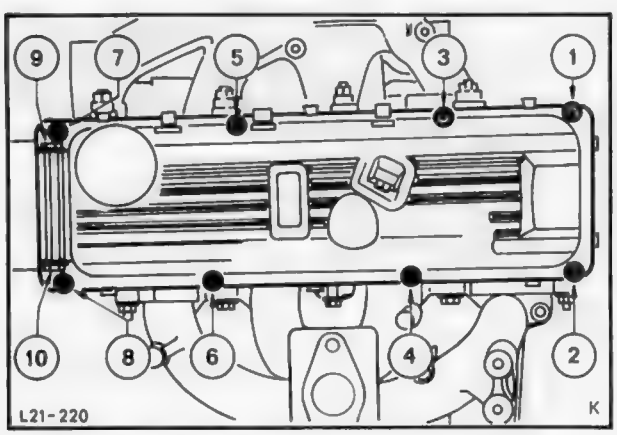


Fig. 143. Rocker cover bolt tightening sequence

21 165 5 CYLINDER HEAD – REPLACE (Cylinder head removed)

Special Service Tools required:

Valve spring compressor (Main tool)	21–024 or 21–056
Adaptors	21–024–02

To Dismantle

1. Remove inlet manifold (5 bolts) complete with carburettor, Fig. 147, and exhaust manifold (6 nuts) from cylinder head.
2. Remove exhaust manifold studs (6) and temperature sender unit.

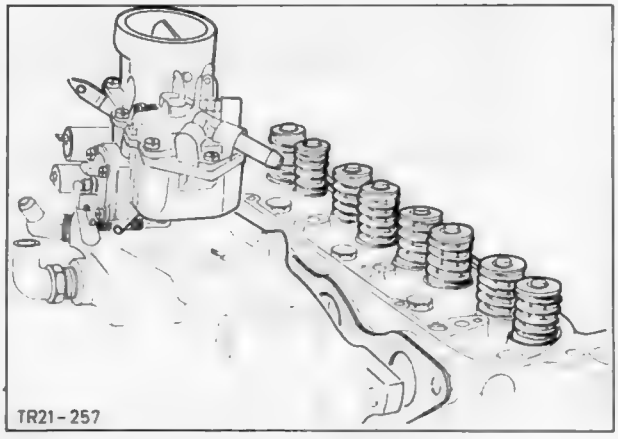


Fig. 147. Remove inlet manifold with carburettor

3. Compress valve springs and retainers using standard valve spring compressor and remove collets. Fig. 148.

   When removing and refitting valve springs it is essential to ensure that the valve stem is not damaged by valve spring retainer when it is pressed down in order to remove and refit collets. If stem is damaged there is no guarantee that sealing is adequate. The result is excessive oil consumption and wear in the valve guides.

4. Release valve spring compressor, remove valve retainers and springs, take off valve stem seals and take out valves.

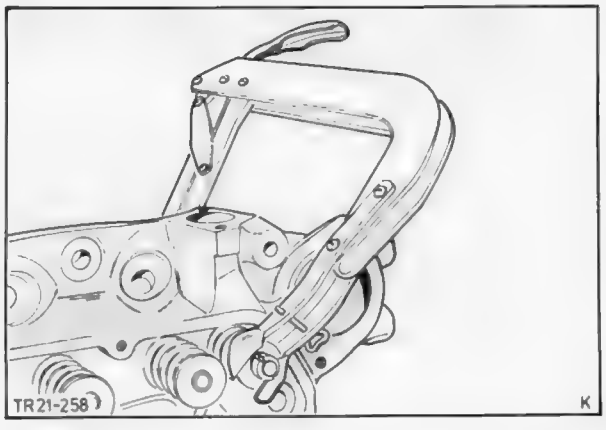


Fig. 148. Removal of valve springs, using standard valve compressor

To Assemble

Before assembling new cylinder head, check parts of old cylinder head intended to be re-used for wear and serviceability.

5. Lubricate valves and valve guides. Insert valves, and cover splines with adhesive foil.
6. Fit valve stem seals, Fig. 149, remove adhesive foil from valve stem.

   Every time valves are taken out and refitted, new valve stem seals should be used. Cover valve splines with adhesive foil to prevent damage to valve stem seals.

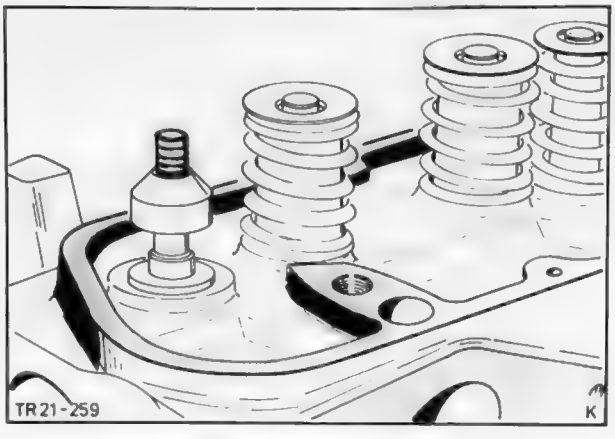


Fig. 149. Slide valve stem seal on valve stem

7. Compress valve springs and valve spring retainers, using valve spring compressor and fit collets. **Pay attention to correct seating of collets.**
8. Refit exhaust manifold studs and temperature sender unit, Fig. 150.

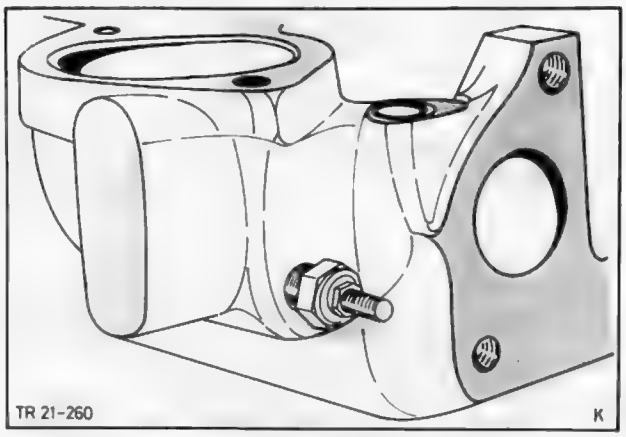


Fig. 150. Fit temperature sender unit

9. Replace inlet manifold complete with carburettor, Fig. 151, and exhaust manifold, using new gaskets.

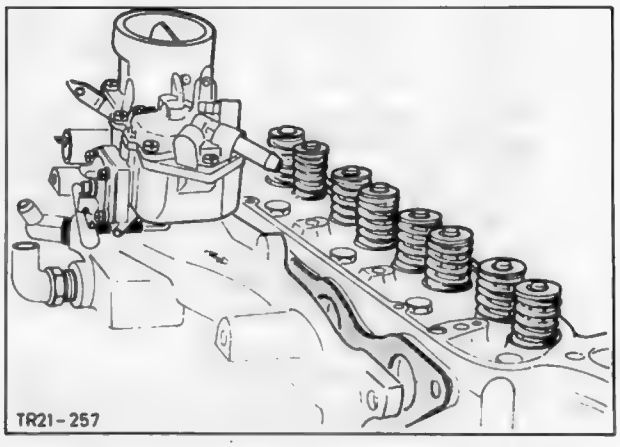


Fig. 151. Install inlet manifold with carburettor

When used valves are installed in a new cylinder head, it is essential before installing them to reface the valve head on a valve grinding machine and then to proceed as follows:

10. Grind in valves in cylinder head, Fig. 152. Clean all traces of grinding paste off valves and valve seats, oil valves, valve seats and inserts. Cover valve splines with adhesive foil.
11. Fit valve seals and remove adhesive foil from valve stem. Continue as described in sub-operation 7.

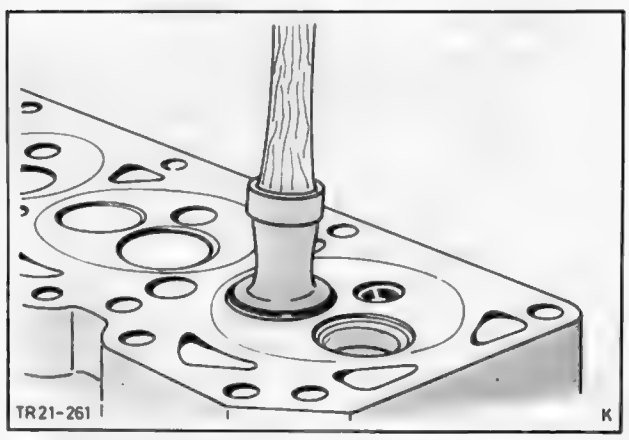


Fig. 152. Grind in valves

21 165 5 CYLINDER HEAD – REPLACE (Cylinder head removed)

Special Service Tools Required:

Valve adjusting locknut wrench	21–004–A
Valve spring compressor	21–005–A
Valve stem oil seal installer	21–007
Camshaft oil seal installer	21–009–A
Oil pump bolt and drive belt tensioner socket	21–012

o Dismantle

1. Support front and rear of cylinder head with two wooden-blocks of equal size in order to prevent damage to valves.
2. Remove inlet manifold (4 bolts, 2 nuts) complete with carburettor, Fig. 153, and water connection (2 bolts) from cylinder head.
3. Remove exhaust pipe (2 bolts) and exhaust manifold (8 nuts).
4. Detach oil pipe (3 bolts). Remove inlet manifold studs (2) and exhaust manifold studs (8) with two lock nuts, as well as temperature sender unit.
5. Unhook cam follower retaining springs, compress valve spring retainer and valve springs using Special Tool 21–005, remove cam followers, Fig. 154, and take out collets, Fig. 155.

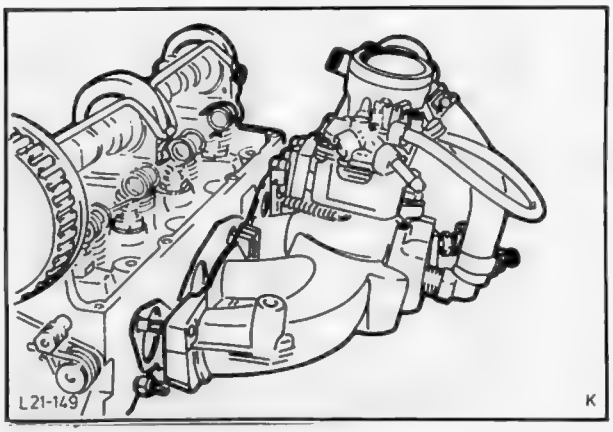


Fig. 153. Remove inlet manifold with carburettor

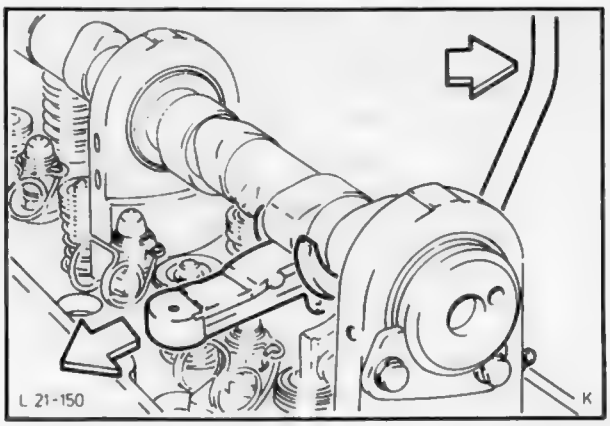


Fig. 154. Remove cam followers using Special Tool 21–005

When removing and refitting valve springs it is essential to ensure that the valve stem is not damaged by valve spring retainer when it is pressed down in order to remove and refit collets. If stem is damaged there is no guarantee that sealing is adequate. The result is excessive oil consumption and wear in the valve guides.

6. Release valve springs. Remove valve spring retainer and valve springs, withdraw valves and remove valve stem seals.

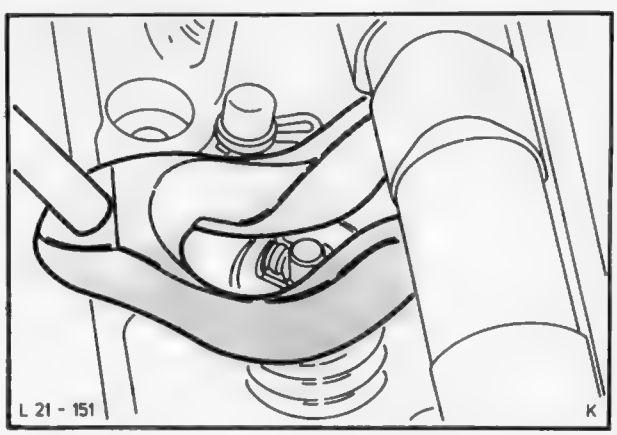


Fig. 155. Remove valve collets, spring retainers and springs, using Special Tool 21–005.

7. Hold camshaft in position with open ended spanner on boss behind 6th cam, detach camshaft gear (1 bolt) and remove together with thrust washer. Remove oil retainer (3 bolts).

8. Remove camshaft retaining plate (2 bolts) and carefully withdraw camshaft to rear. Remove ball pins (8).

   Do not interchange re-used camshaft, cam followers and ball pins when removing and re-installing.

9. Remove toothed belt tensioner (2 bolts, 1 spring), using Special Tool 21–012, Fig. 156, and remove toothed belt guard spacer bolts (2).

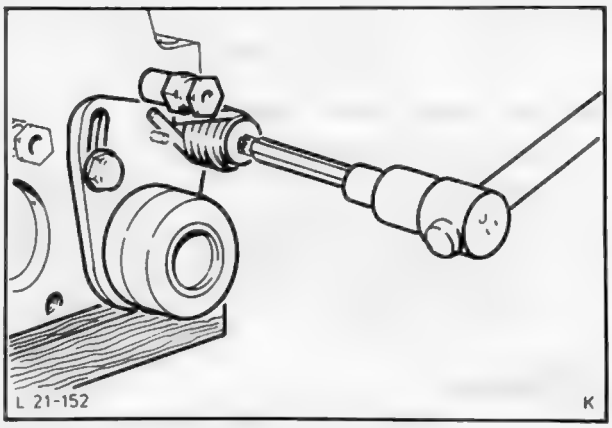


Fig. 156. Remove toothed belt tensioner, using Special Tool 21–012

To Install

Before assembling new cylinder head check parts of old cylinder head intended to be re-used for wear and serviceability.

When fitting new parts, e.g. camshaft, cam followers or valves proceed as follows:

10. Fit inlet and exhaust manifold studs and temperature sender unit.

11. Lubricate camshaft bearings, camshaft, retaining plate, ball pins and cam followers with hypoid oil SAE 80/90.

12. Carefully insert camshaft through rear bearing, Fig. 157. Fit retaining plate and measure camshaft end-float using dial indicator (see Technical Data).

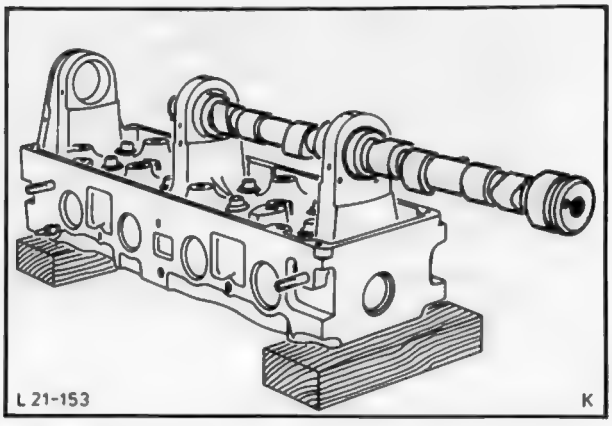


Fig. 157. Fit camshaft

13. Fit ball pin complete with lock nut, Fig. 158. Lubricate valve guides and valves with hypoid oil SAE 80/90. Insert valves and cover valve splines with adhesive foil.

14. Lubricate valve guides and valves with hypoid oil SAE 80/90. Insert valves and cover splines with adhesive foil.

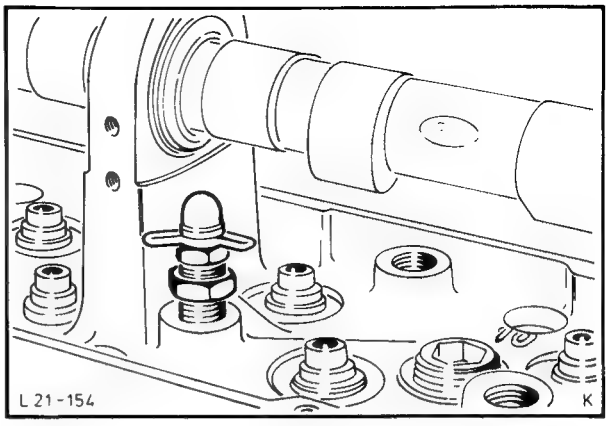


Fig. 158. Fit ball pin with lock nut and retaining clip

15. Lubricate valve stem seals and install on stems provided on new cylinder head, using Special Tool 21–007, Fig. 159. Remove adhesive foil from valve stem.

Every time valves are removed and refitted new valve stem seals should be used and valve splines covered with adhesive foil to avoid damage to valve stem seals.

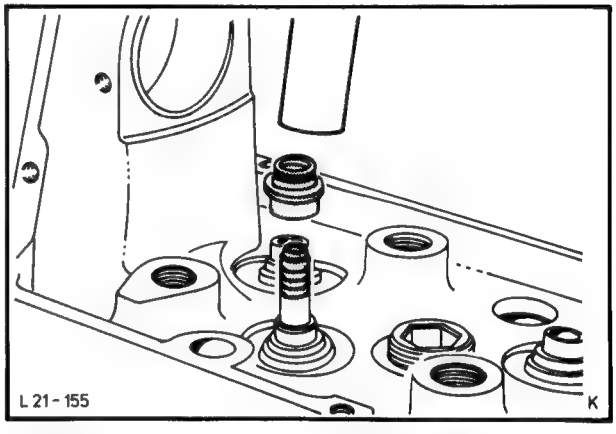


Fig. 159. Fit valve stem seals using Special Tool 21–007

16. Fit valve springs and retainers, compress with Special Tool 21–005 and fit valve collets, Fig. 160. Insert cam followers.

Check correct seating of valve collets.

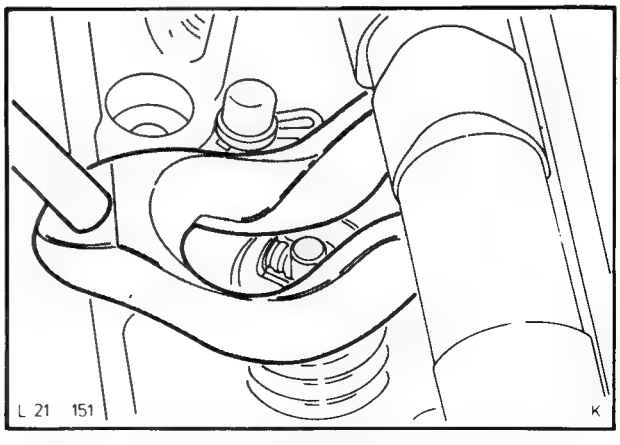


Fig. 160. Fitting of valve springs, retainers and collets, with Special Tool 21–005

21 165 5 (cont'd)

17. Lightly grease sealing lip of new oil seal and install oil seal, using Special Tool 21–009–A, Fig. 161.

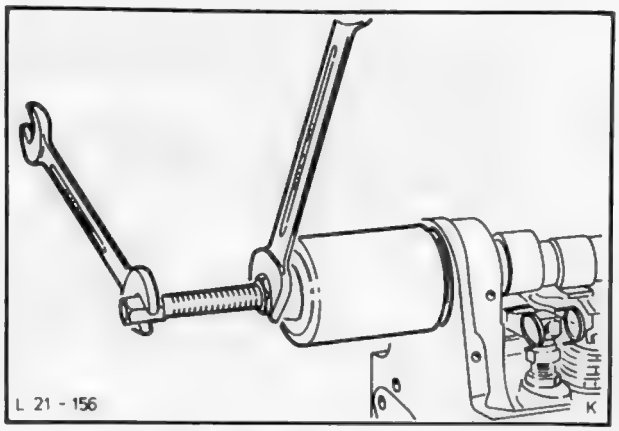


Fig. 161. Fit oil seal, using Special Tool 21–009–A

18. Fit camshaft pulley thrust washer with reinforced side facing outward. Torque bolt as specified in Technical Data, holding camshaft in position with open-ended spanner, Fig. 162.

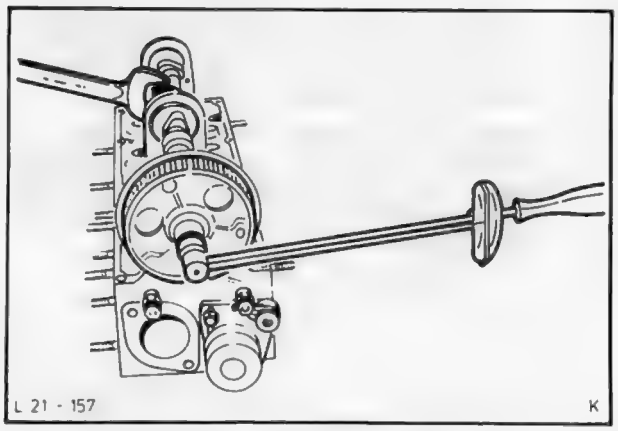


Fig. 162. Tighten camshaft pulley bolt to specified torque

19. Secure cam followers by means of retaining springs, Fig. 163, adjust valve clearances using Special Tool 21–004–A (see Operation No. 21 213 'B' engine).

20. Install toothed belt guard spacer bolts together with tensioner.

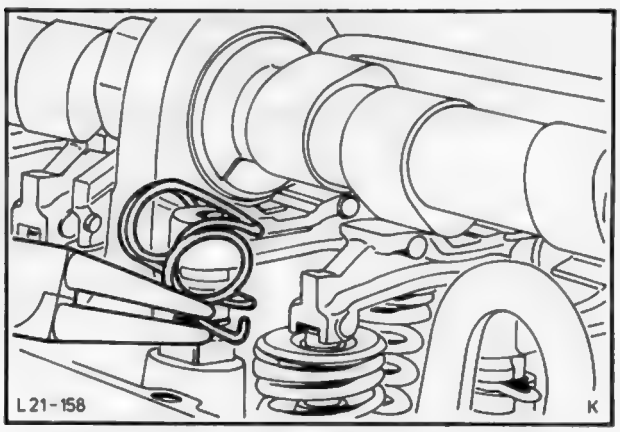


Fig. 163. Secure cam follower by means of retaining springs

21. Fit oil splash tube and fit water connection complete with thermostat and new gasket to cylinder head, Fig. 164.

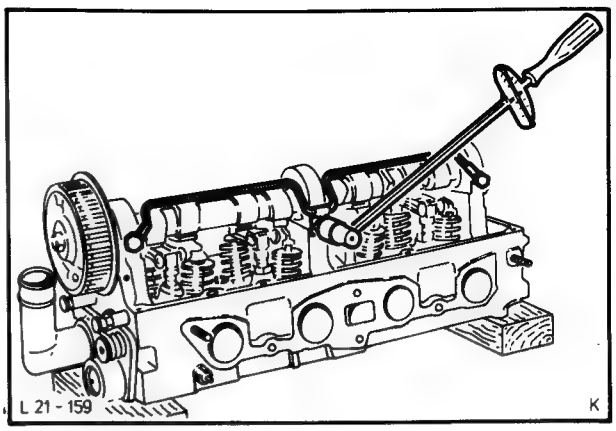


Fig. 164. Fit oil slinger pipe

22. Fit inlet manifold complete with carburettor and exhaust manifold with new gaskets. Apply sealing compound Part No. A 70SX-19554-BA not less than 5 mm (0,2 in) wide to either side of gasket on water connection (cylinder head – inlet manifold), Fig. 165. Fit exhaust manifold shield.

When used valves are installed in a new cylinder head it is essential before installing them to reface valve head on a valve grinding machine and then to proceed as follows:

23. Grind in valves in cylinder head, clean all traces of grinding paste off valves and valve seats, oil and insert valves.

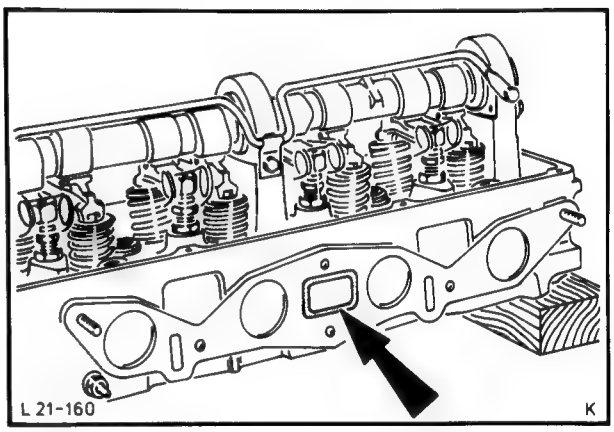


Fig. 165. Apply sealing compound to either side of inlet manifold gasket

24. Cover valve splines with adhesive foil and fit lubricated valve stem seals using Special Tool 21–007, Fig. 166.

Cover valve splines with adhesive foil to prevent damage to splines.

25. Remove adhesive foil from valve stem, fit valve springs and valve retainers, compress with Special Tool 21–005, fit collets and cam followers.

Pay attention to correct seating of valve collets.

Carry out remaining repair operations as described from sub-operation 17 onwards.

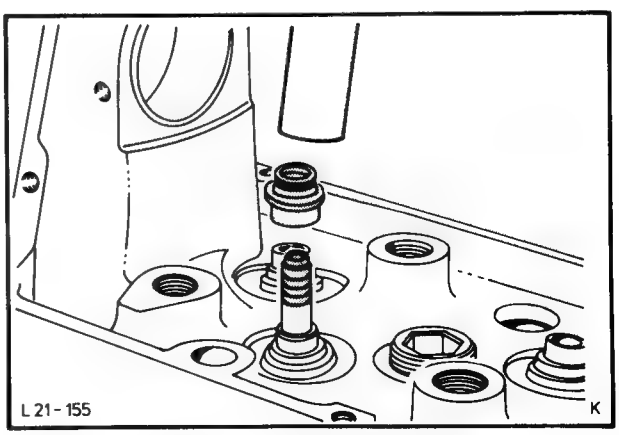


Fig. 166. Fit valve stem seals using Special Tool 21–007

21 213 VALVE CLEARANCES – ADJUST (ALL)

Special Service Tools Required: None

1. Remove air cleaner, disconnect HT leads from spark plugs and remove rocker cover.
2. During adjustment of valve clearances, crank engine only in direction of normal rotation. For first valve adjustment, align crankshaft pulley mark with TDC mark on timing cover, Fig. 167.

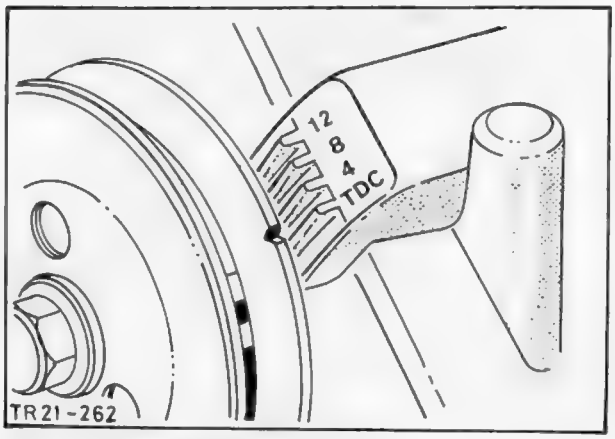


Fig. 167. Pulley on TDC mark

If pulley is now turned to and fro a little the valves of cylinders No. 1 or 4 will be rocking, Fig. 168, i.e. the two rocker arms and push rods move in opposite directions. If the valves of cylinder No. 4 are rocking the valve clearances on No. 1 cylinder should be adjusted. If pulley is now turned through 180°, valve clearances on No. 2 or No. 3 cylinder can be adjusted etc. according to firing order (for adjustment see Technical Data).

Cylinder No. 4 rocking – Adjust cylinder No. 1.
Cylinder No. 3 rocking – Adjust cylinder No. 2.
Cylinder No. 1 rocking – Adjust cylinder No. 4.
Cylinder No. 2 rocking – Adjust cylinder No. 3.

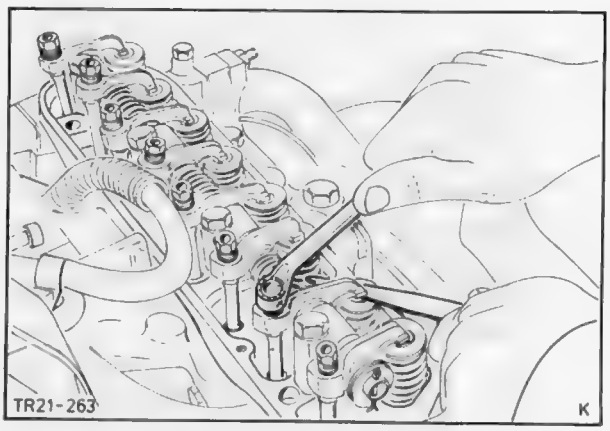


Fig. 168. Adjust valve clearances of No. 1 cylinder

3. Replace rocker cover and torque bolts to specification. Connect HT leads, Fig. 169, and fit air cleaner.

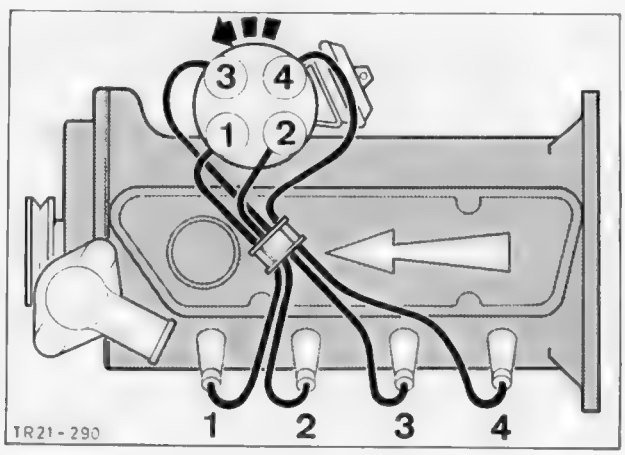


Fig. 169. HT lead arrangement (Firing order)

21 213 VALVE CLEARANCES – ADJUST (ALL)

Special Service Tool Required:

Valve adjustment locknut wrench 21–004–A

1. Remove air cleaner. Disconnect HT leads from spark plugs and remove rocker cover (10 bolts).
2. Adjust valve clearances, proceeding as follows: Rotate cams one by one so that they point upwards and measure valve clearance between cam follower and cam, Fig. 170. Adjust clearance at ball pin. Torque ball pin lock nut as specified in Technical Data, using Special Tool 21–004–A (see Technical Data).

Crank engine in direction of rotation only

3. Fit rocker cover, ensuring correct engagement of gasket protrusion.
4. Tighten rocker cover bolts to specified torque in four stages, as shown in Fig. 171.

   1st stage, tighten bolts 1–6.
   5 to 7 Nm (0,5 to 0,7 kgf.m) (4,4 lbf.ft)
   2nd stage, tighten bolts 7 and 8
   2 to 2,5 Nm (0,2 to 0,25 kgf.m) (1,7 lbf.ft)
   3rd stage, tighten bolts 9 and 10
   5 to 7 Nm (0,5 to 0,7 kgf.m) (4,4 lbf.ft)
   4th stage, tighten bolts 7 and 8
   5 to 7 Nm (0,5 to 0,7 kgf.m) (4,4 lbf.ft).

5. Connect HT leads, Fig. 172, and fit air cleaner.

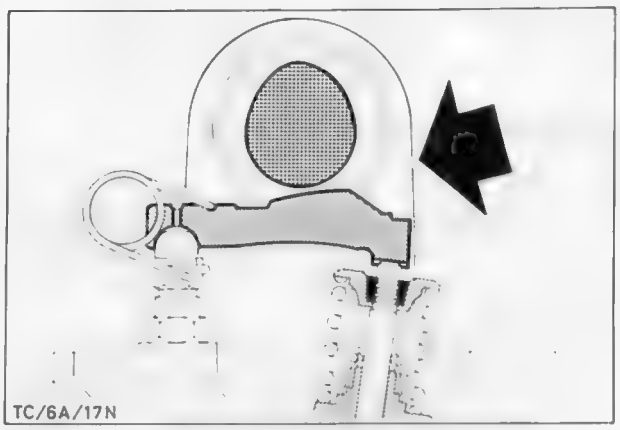


Fig. 170. Measure valve clearance

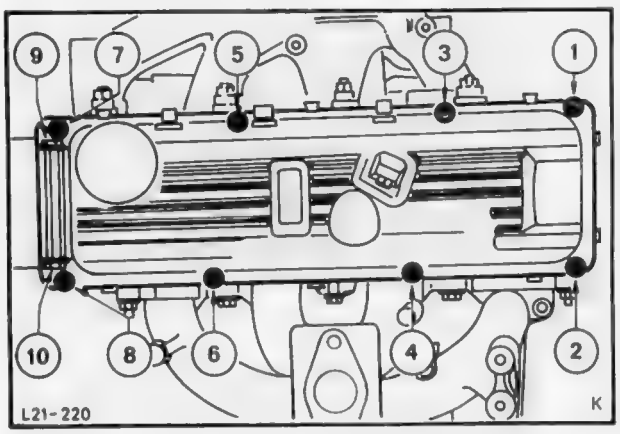


Fig. 171. Rocker cover bolt tightening sequence

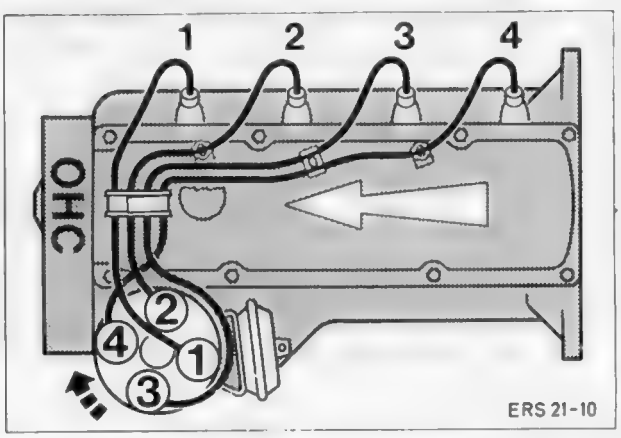


Fig. 172. Arrangement of HT leads (firing order)

21 215 4 VALVE – REMOVE AND INSTALL (ONE) (Cylinder head removed)

Special Service Tools Required:

'B' ENGINE

Valve spring compressor	21–005–A
Valve stem oil seal installer	21–007

To Remove

1. On the 'B' engine, disconnect cam follower retaining spring, compress valve spring and retainer using Special Tool 21–005–A and take out cam follower, Fig. 173.
2. Compress valve spring and valve retainer with standard valve spring compressor and take out collets, Fig. 174.

   When removing and refitting valve springs it is essential to ensure that the valve stem is not damaged by valve spring retainer when it is pressed down in order to remove and refit collets. If stem is damaged there is no guarantee that sealing is adequate. The result is excessive oil consumption and wear in the valve guides.
3. Slacken valve spring compressor, remove valve spring retainer and valve spring. Remove valve stem seal and withdraw valve.

To Install

4. Grind in valve in cylinder head, Fig. 152. Clean all traces of grinding paste off valve and valve seat. Insert and cover valve splines with adhesive foil.
5. Lubricate valve stem seal and install (on 'B' engine using Special Tool 21–007), Fig. 175. Remove adhesive foil from valve stem.

   Use new valve stem seal whenever valve is removed and installed. Cover valve splines with adhesive foil in order to prevent damage to valve splines.
6. Fit valve spring and valve spring retainer, compress with valve spring compressor and fit collets.

   Pay attention to correct seating of collets.
7. On the 'B' engine, compress valve spring and retainer with Special Tool 21–005–A and insert cam follower. Secure cam follower using the retaining spring.

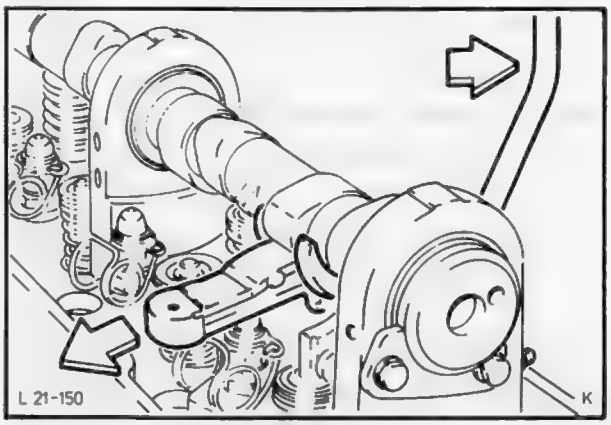


Fig. 173. Remove cam follower with Special Tool 21–005–A, 'B' engine

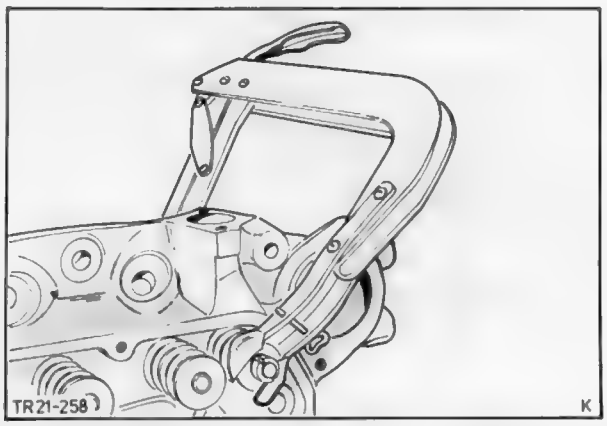


Fig. 174. Remove collets with standard valve spring compressor, – 'A' engine

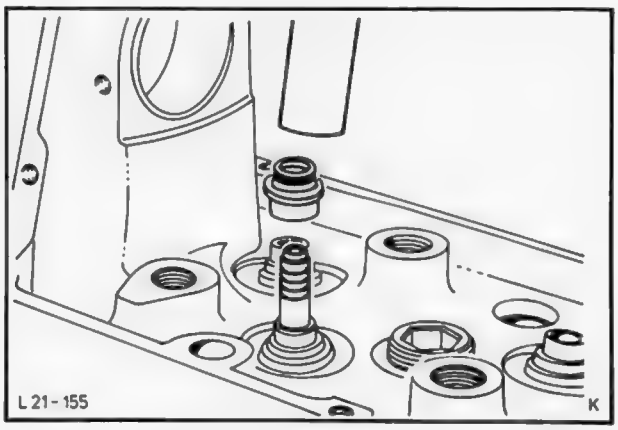


Fig. 175. Fit valve stem seal, using Special Tool 21–007, 'B' engine

21 233 9 VALVE GUIDE – REAM (Valve removed)

Special Service Tools Required:

'A' engine

Valve guide reamer	21–042

'B' engine

Valve guide reamer	
0,2 mm oversize	21–071
0,4 mm oversize	21–072
0,6 mm oversize	21–073
0,8 mm oversize	21–074

1. Insert existing valve in valve guide and determine play by pressing sideways, Fig. 176.

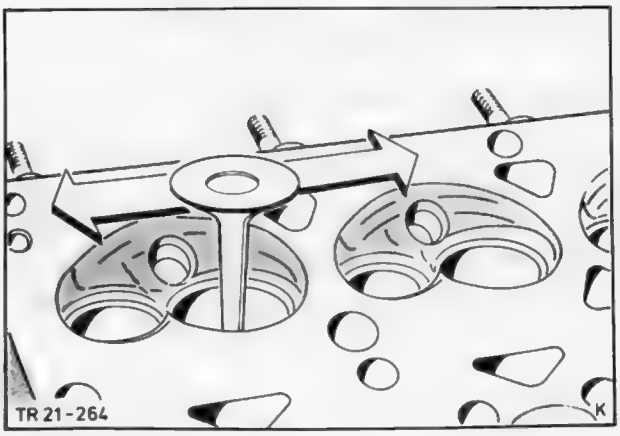


Fig. 176. Measure valve guide play by pressing sideways

2. Using reamer, ream valve guide from valve seat end, Fig. 177. After they have been used for a considerable time valve guides wear into an oval shape. When rectifying, reaming should always be carried out from the **valve seat end.** The size of bore chosen depends on the amount of wear of the guide bore and the valve oversizes available (see Parts Catalogue). When reaming the **smallest** reamer should always be used initially, since with the larger ones the depth of cut is too great. To lubricate, use drilling oil or petrol.

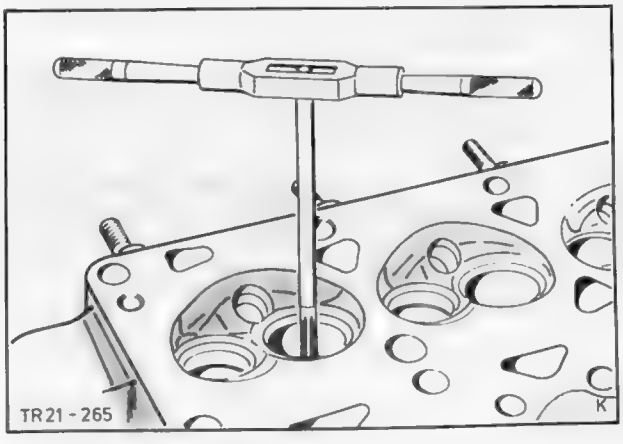


Fig. 177. Ream valve guide

3. Using Special Tool recut valve seat as specified (see Technical Data), Fig. 178.

Before seat is recut, it is essential that the valve guide be checked or reamed using the appropriate Special Tool.

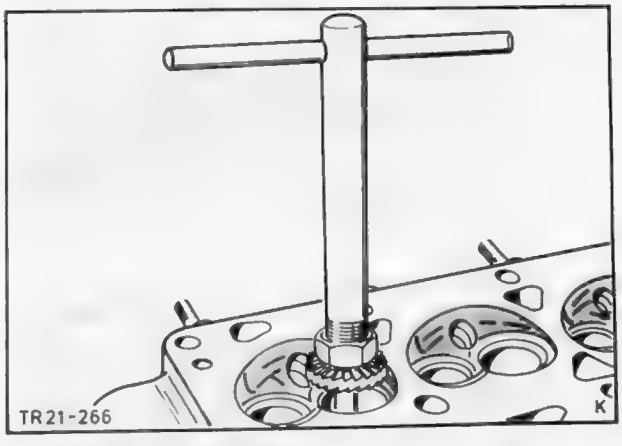


Fig. 178. Recut valve seat

21 238 SEALS – VALVE STEM – REPLACE

Special Service Tools Required:

Valve spring compressor 21–056
(or 21–024 in conjunction with 21–024–02)
Valve retainer 21–057

To Remove

1. Disconnect earth strap from battery and take off air cleaner.

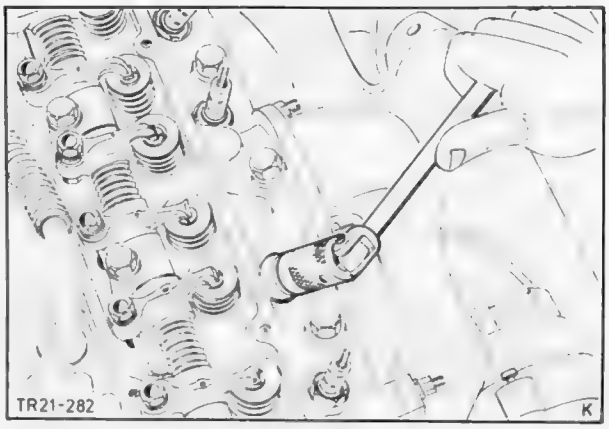


Fig. 179. Remove sparking plugs

2. Disconnect HT leads from spark plugs and remove rocker cover bolts.
3. Unscrew spark plugs, remove rocker shaft Fig. 179, together with valve stem seals and remove push rods.

   Do not interchange push rods when removing and installing.

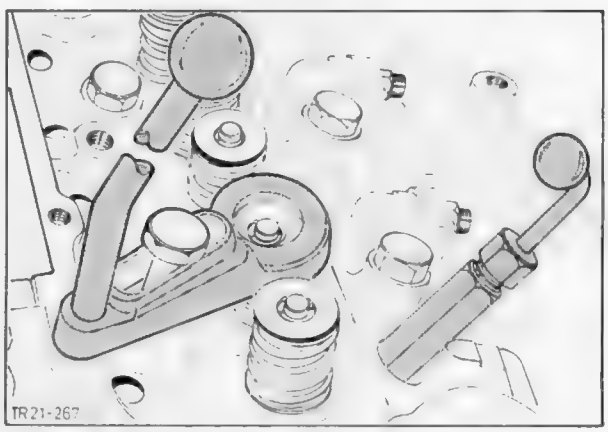


Fig. 180. Removing valve spring with Special Tools 21–056 and 21–057

4. Screw valve holder 21–057 into spark plug hole, position against valve spring retainer and lock. Fit valve spring compressor 21–056 (or 21–024 in conjunction with 21–024–02) to cylinder head, Fig. 180.
5. Press valve spring down, remove collets, Fig. 181, and release pressure on spring. Remove valve spring retainer, valve spring and valve stem seal.

   When removing and refitting valve springs it is essential to ensure that the valve stem is not damaged by valve spring retainer when it is pressed down in order to remove and refit collets. If stem is damaged there is no guarantee that sealing is adequate. The result is excessive oil consumption and wear in the valve guides.

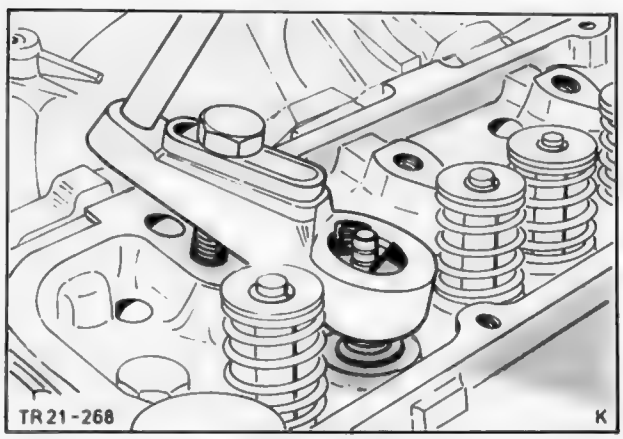


Fig. 181. Remove collets

To Install

6. Cover valve spline with adhesive foil, slide new valve stem seal down valve stem, Fig. 182, against stop. Remove adhesive foil from valve stem. Fit valve spring and valve spring retainer, compress with Special Tool and fit collets. Release pressure on valve spring and remove Special Tool.

   Pay attention to correct seating of collets.

   Repeat sub-operations 4–6 on each cylinder.

   Use new valve stem seal whenever valve is removed and installed. Cover valve splines with adhesive foil to prevent damage to valve stem seal.

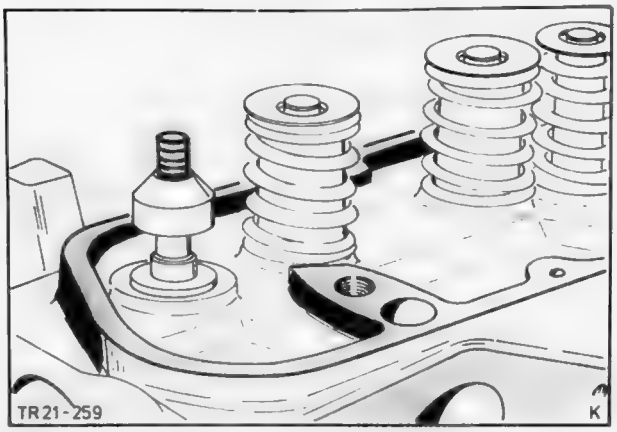


Fig. 182. Fit seal to valve stem

7. Insert push rods into tappet sockets. Position rocker shaft guiding rocker arm adjusting screws into push rod sockets. Replace rocker shaft bolts and torque as specified, Fig. 183, (see Technical Data).

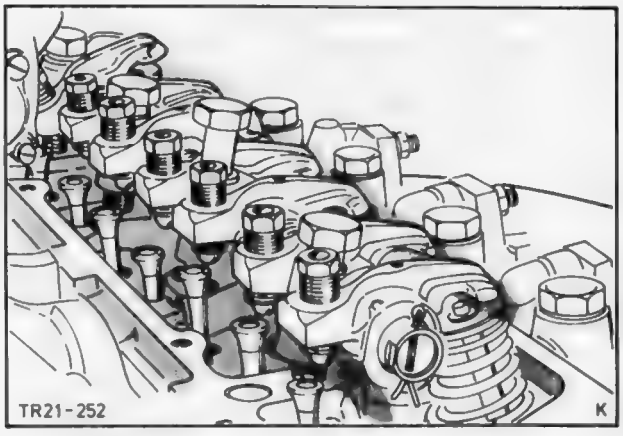


Fig. 183. Torque rocker shaft bolts as specified (see Technical Data)

8. Adjust valve clearances (see Operation No. 21 213).
9. Screw in spark plugs and replace rocker cover.
10. Connect HT leads to spark plugs, Fig. 184, refit air cleaner. Connect earth strap to battery.

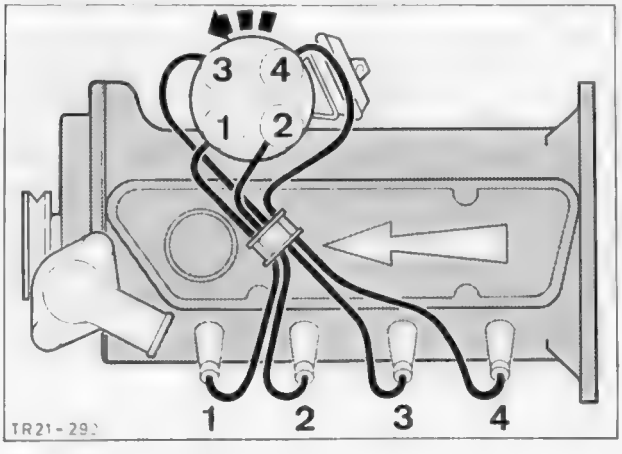


Fig. 184. HT leads (firing order)

21 238 SEALS – VALVE STEM – REPLACE (ALL)

Special Service Tools Required:

Valve spring compressor	21–005–A
Valve retainer	21–006–A
Valve stem oil seal installer	21–007

To Remove

1. Disconnect earth strap from battery and remove air cleaner.
2. Disconnect HT leads from spark plugs and rocker cover. Remove rocker cover and remove spark plugs.
3. Unhook cam follower springs, Fig. 185, press valve spring and valve spring retainer down, using Special Tool 21–005–A, and remove cam followers, Fig. 186.

   Do not interchange cam followers when removing and installing.
4. Remove heat shield (2 bolts) from exhaust manifold. Screw valve retainer 21–006–A into spark plug hole, position it against valve head and lock.

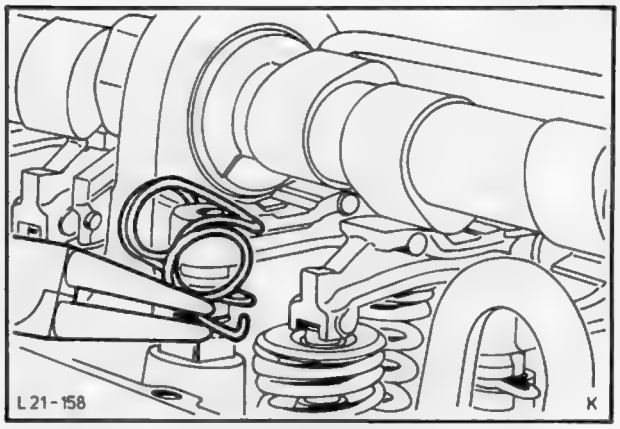


Fig. 185. Unhook cam follower springs

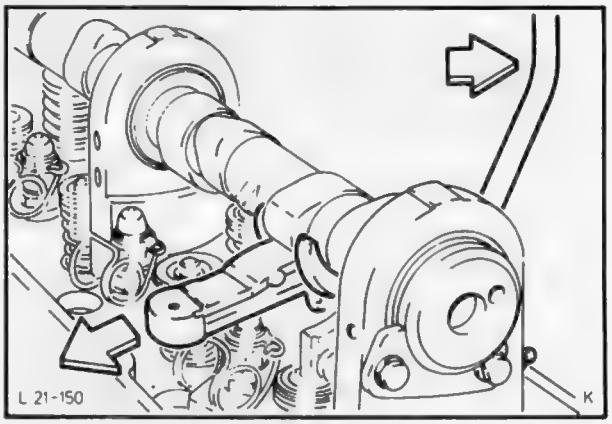


Fig. 186. Remove cam follower using Special Tool 21–005–A

5. Press valve spring and valve spring retainer down, using Special Tool 21–005–A, Fig. 187. Remove collets and release pressure on spring.

   When removing and refitting valve springs it is essential to ensure that the valve stem is not damaged by valve spring retainer when it is pressed down in order to remove and refit collets. If stem is damaged there is no guarantee that sealing is adequate. The result is excessive oil consumption and wear in the valve guides.

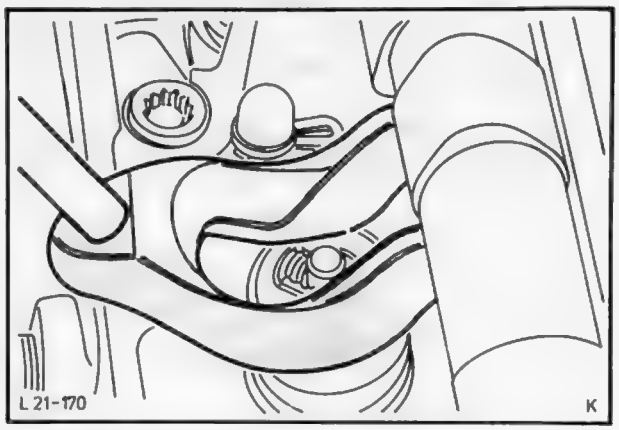


Fig. 187. Remove valve spring using Special Tools 21–005–A and 21–006–A

6. Remove valve spring retainer and valve spring. Prise valve stem seal off cylinder head with screwdriver, Fig. 188.

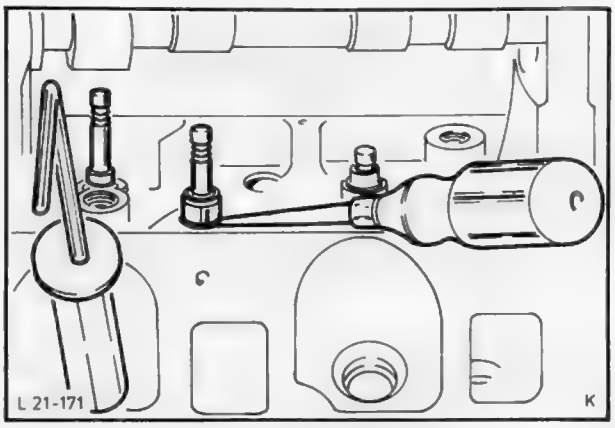


Fig. 188. Remove valve stem seal using screwdriver

To Install

7. Cover valve splines with adhesive foil. Fit new lubricated valve stem seal using Special Tool 21–007, Fig. 189, and remove adhesive foil from valve stem. Position valve spring and valve spring retainer, press down using Special Tool 21–005–A and fit collets. Release pressure on spring and remove Special Tool.

   Pay attention to correct seating of collets.

   Before installing valve stem seals cover valves splines with adhesive foil to prevent damage to valve stem seals.

   Use new valve stem seal whenever valve is removed and installed.

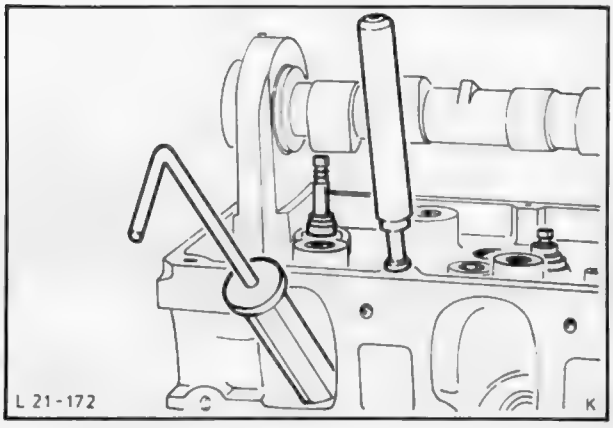


Fig. 189. Fit valve stem seal, using Special Tool 21–007

8. Fit cam followers and cam follower springs. Check valve clearances and adjust, if necessary. (Refer to Operation 21–213 Engine–'B').
9. Fit spark plugs and rocker cover as specified. Bolt heat shield to exhaust manifold.
10. Connect HT leads, Fig. 190, and connect battery earth strap.

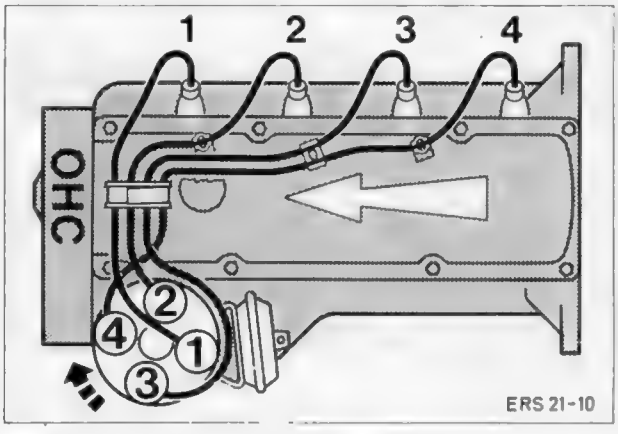


Fig. 190. Arrangement of HT leads (firing order)

21 255 9 ROCKER SHAFT – DISMANTLE AND REASSEMBLE (Rocker shaft removed)

Special Service Tools Required: None

To Dismantle

1. Remove split pin from one end of rocker shaft (Fig. 191).
2. Remove spring washer and two washers.
3. Remove rocker arms, rocker supports and springs. Knock off jammed rocker supports with a plastic hammer.

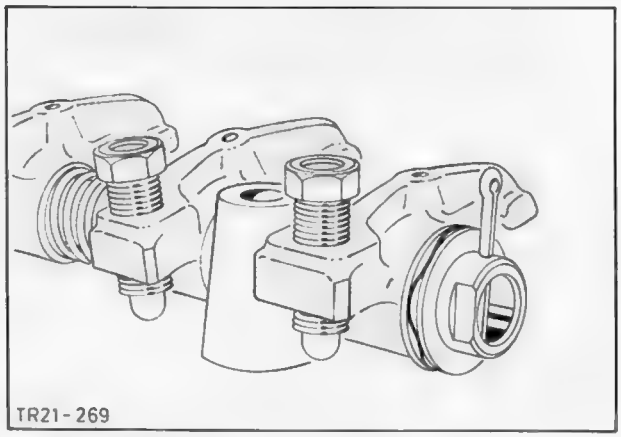


Fig. 191. Remove split pin from rocker shaft

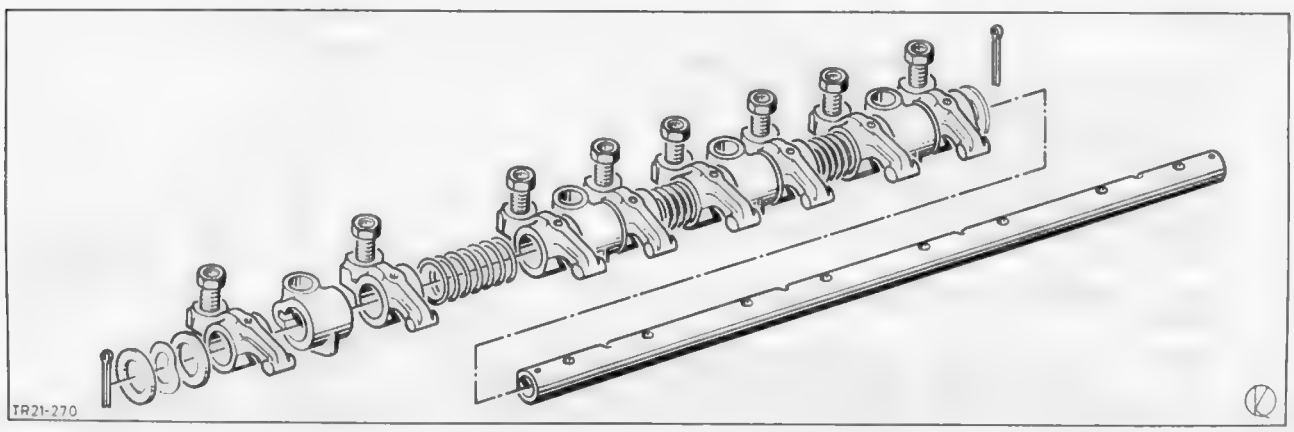


Fig. 192. Rocker shaft dismantled

To Reassemble

4. Assemble rocker shaft as shown in Fig. 192, first lubricating rocker shaft and rocker arm bearing faces with hypoid oil SQM-2C-9002-AA.

   When assembled, the oil port for rocker arm lubrication must point **to the front and downwards.** This position is marked by a notch on the end face of the completely assembled rocker shafts, Fig. 193.

   On new rocker shaft, note the end covers, Fig. 193.

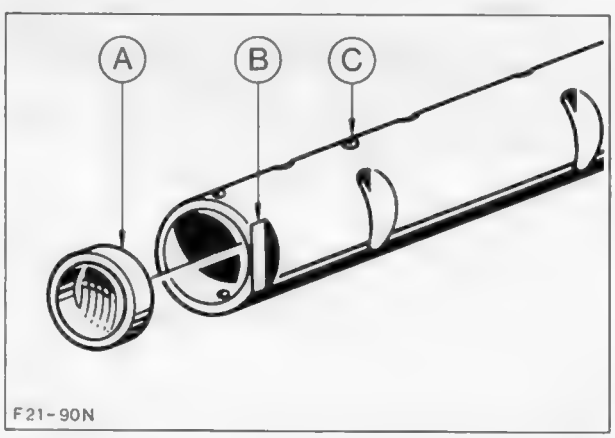


Fig. 193. Front end of rocker shaft (viewed from underneath)
A – End cover
B – Notch
C – Oil port

21 288 SEAL – CAMSHAFT – REPLACE

Special Service Tools Required:

Oil seal remover	21-008-A
Oil seal installer	21-009-A
Oil pump bolt and drive belt tensioner socket	21–012

To Remove

1. Disconnect battery earth strap. Drain coolant into tray, disconnecting radiator hose from radiator bottom neck, Fig. 194, and engine water outlet at top.

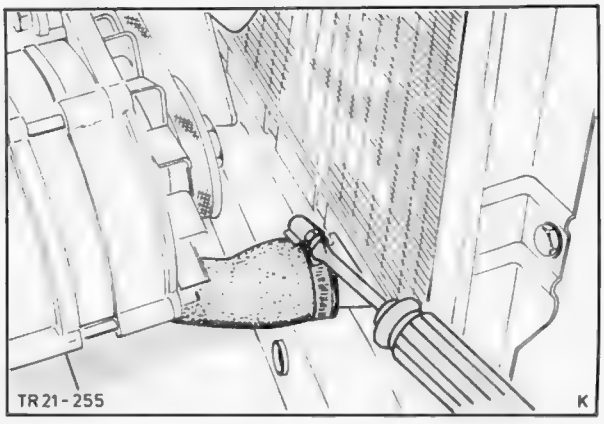


Fig. 194. Disconnect radiator hose from radiator

2. Remove radiator (4 bolts) and toothed belt guard (3 bolts), Fig. 195. Detach water outlet elbow (2 bolts).

To avoid damage to valves and pistons the following is essential: Before detaching toothed belt, crank engine until crankshaft belt pulley is set on TDC mark on timing cover and thrust washer of camshaft toothed belt pulley lines up on 1st cylinder mark on cylinder head.

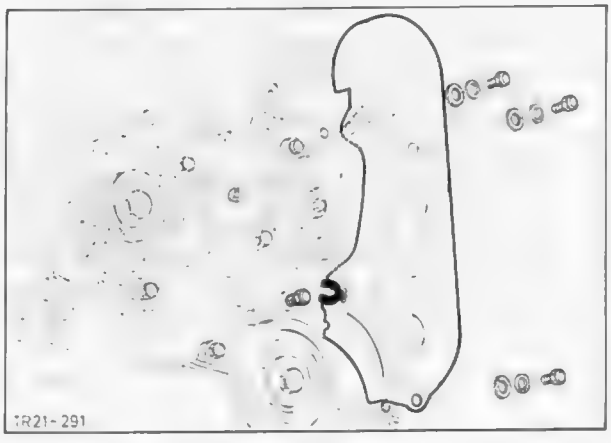


Fig. 195. Remove toothed belt guard (fan removed for clarity)

3. Remove camshaft pulley bolt. Slacken toothed belt tensioner, using Special Tool 21–012 (1 hexagon bolt, 1 special bolt), Fig. 196 against spring pressure and retighten. Remove toothed belt from camshaft belt pulley (see note below).

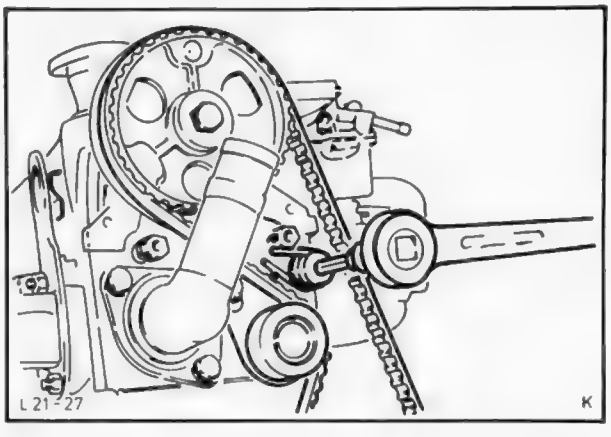


Fig. 196. Slacken toothed belt tensioner using Special Tool 21–012

4. Remove camshaft pulley and thrust washer. Remove oil seal using Special Tool 21–008–A, Fig. 194.

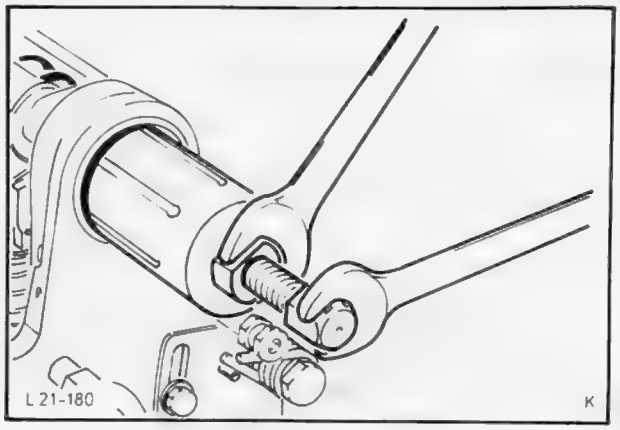


Fig. 197. Remove oil seal, using Special Tool 21–008–A

Prior to each refitting of toothed belt always check whether camshaft pulley, crankshaft pulley and distributor rotor are aligned on cylinder No. 1 TDC mark, Fig. 198. If after removal of toothed belt camshaft and crankshaft marks were found to be no longer aligned camshaft or crankshaft must not in any circumstances be rotated through 360° to achieve alignment on mark. Choose shortest travel to mark, ensuring that pistons and valves are not fouling.

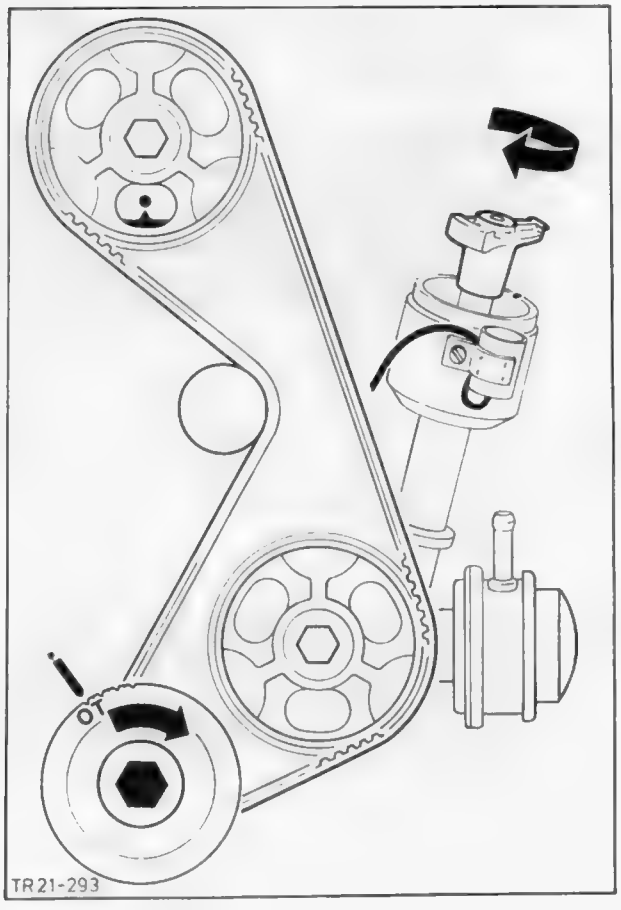


Fig. 198. No. 1 piston in TDC

To Install

5. Fit new oil seal (with sealing lip slightly oiled) using Special Tool 21–009–A, Fig. 199.
6. Slide thrust washer with reinforced side facing outwards and camshaft belt pulley, into position and secure with bolt.
7. Check whether camshaft, crankshaft and distributor rotor are aligned on cylinder No. 1 TDC mark. Position toothed belt.

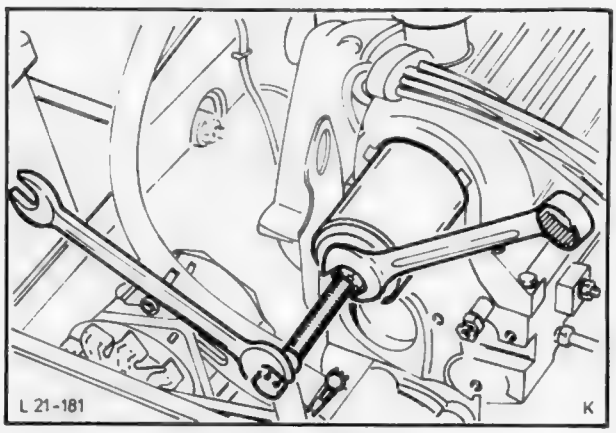


Fig. 199. Fit camshaft oil seal using Special Tool 21–009–A

8. Slacken toothed belt tensioner to enable it to become positioned against toothed belt after cranking engine twice, Fig. 200. After cranking torque tensioner and camshaft pulley bolts as specified in Technical Data. (Hexagonal bolt first, then special bolt.)

   After positioning of toothed belt crank engine in direction of rotation only.

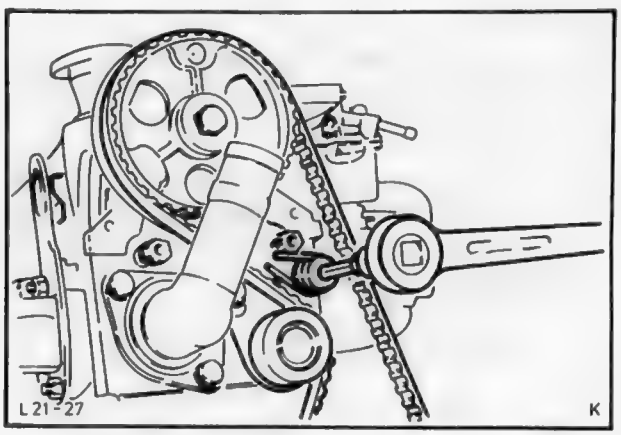


Fig. 200. Slacken toothed belt tensioner, using Special Tool 21–012

9. Fit water connections and toothed belt guard. Fig. 201.
10. Fit radiator, connect radiator hoses and top up with coolant.
11. Connect battery earth strap, check engine oil level and top up, if necessary.

Fig. 201. Fit toothed belt guard

21 467 SEAL – CRANKSHAFT FRONT – REPLACE

Special Service Tools Required:

Crankshaft front oil seal installer	21–046
Milti-purpose oil seal remover	21–051

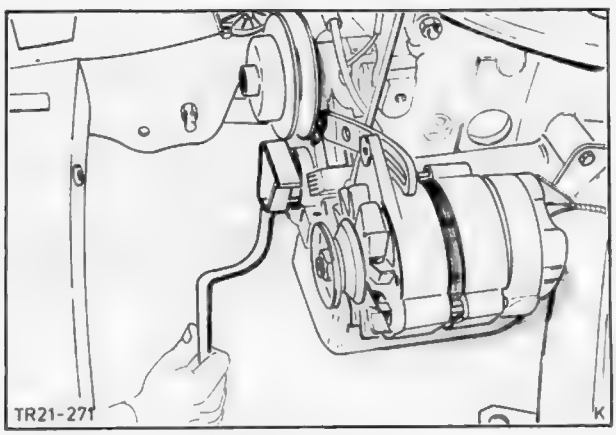


Fig. 202. Remove oil seal using Special Tool 21–051

To Remove

1. Disconnect earth strap from battery. Drain coolant, by disconnecting radiator hoses from lower radiator neck and from engine water elbow at top.
2. Remove radiator complete with fairing (4 bolts). Slacken alternator bolts and pivot alternator to the side. Remove V-belt. Remove fan (4 bolts) and crankshaft belt pulley (1 bolt).
3. Remove crankshaft oil seal using Special Tool 21–051 as shown in Fig. 202.

To Install

4. Press in a new oil seal (sealing lip lightly oiled), using Special Tool 21–046 in conjunction with pulley and bolt, as shown in Fig. 203.
5. Remove special tool, fit fan and pulley, torquing bolts as specified in Technical Data. Replace alternator V-belt and tension to achieve 13 mm (0,5 in) movement midway between alternator and fan pulleys.
6. Install radiator with fairing. Attach radiator hoses and fill with coolant.
7. Reconnect earth strap to battery. Check engine oil level and top up if necessary.

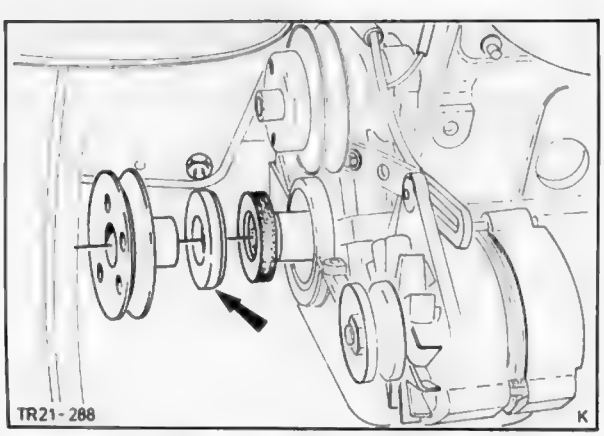


Fig. 203. Fit oil seal. Special Tool No. 21–046

21 467 SEAL – CRANKSHAFT FRONT – REPLACE

Special Service Tools Required:

Oil seal remover	21–008–A
Oil seal installer	21–009–A
Drive belt tensioner socket	21–012
Crankshaft gear remover	21–028

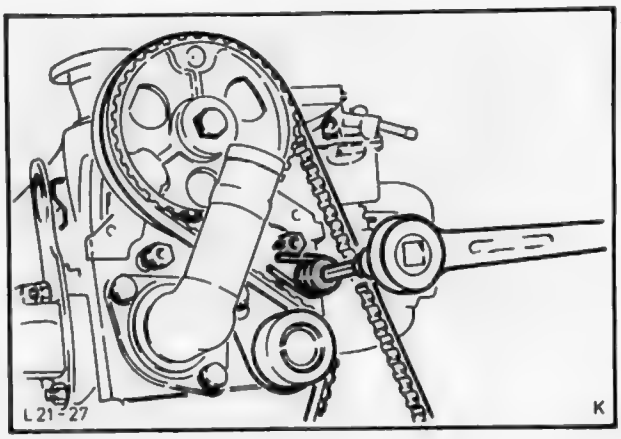


Fig. 204. Slacken toothed belt tensioner using Special Tool 21–012

To Remove

1. Disconnect earth strap from battery. Drain coolant into tray by disconnecting radiator hoses from lower radiator neck and from engine water elbow.
2. Remove radiator (4 bolts). Slacken alternator bolts and pivot alternator. Take off V-belt. Remove crankshaft pulley (1 bolt) with thrust washer and toothed belt guard (3 bolts).
3. Slacken toothed belt tensioner using Special Tool 21–012 (1 hexagon bolt, 1 special bolt), Fig. 204, press against spring pressure and retighten.

   Remove toothed belt. Pull off crankshaft pulley using Special Tool 21–028, Fig. 205, and withdraw oil seal with Special Tool 21–008–A, Fig. 206.

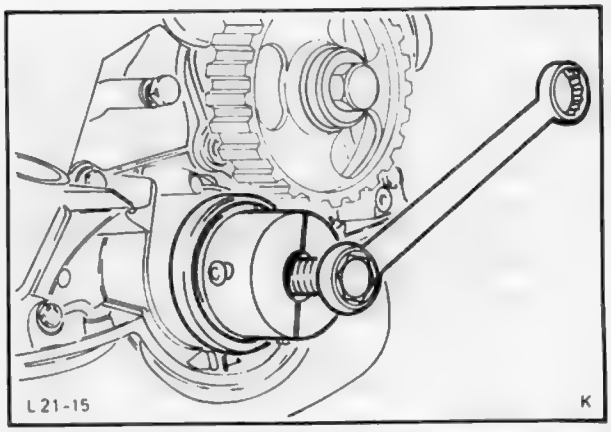


Fig. 205. Pull off crankshaft pulley using Special Tool 21–028

In order to prevent damage to pistons and valves it is essential for the following operations to be carried out:

Prior to removal of toothed belt always crank engine until mark on crankshaft pulley is aligned on TDC mark on timing cover and mark on camshaft pulley thrust washer is aligned on No. 1 cylinder head mark. Leave engine in this position, remove toothed belt and continue operations without any further cranking of engine.

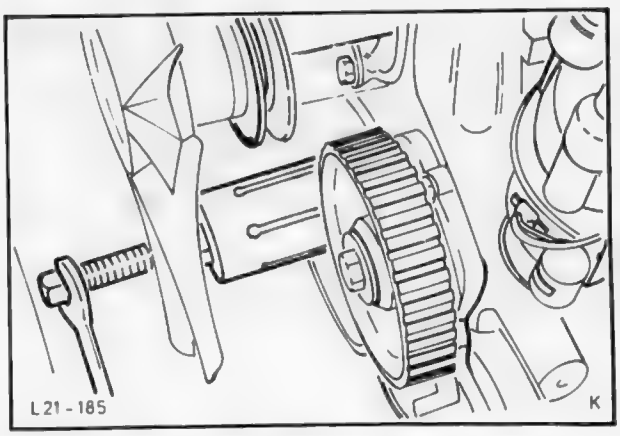


Fig. 206. Remove oil seal using Special Tool 21–008–A

Prior to each refitting of toothed belt always check whether camshaft pulley, crankshaft pulley and distributor rotor are aligned on cylinder No. 1 TDC mark. If after removal of toothed belt, camshaft and crankshaft marks were found to be no longer aligned camshaft or crankshaft must not in any circumstances be rotated through 360° to achieve alignment on mark. Choose shortest travel to mark, ensuring that pistons and valves are not fouling.

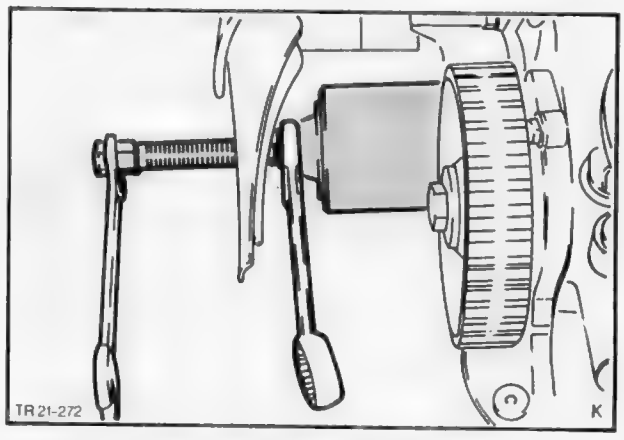


Fig. 207. Fit oil seal, using Special Tool 21–009–A

To Install

4. Fit new oil seal (with sealing lip slightly oiled), using Special Tool 21–009–A, Fig. 207. Fit crankshaft toothed belt pulley (with chamfered side inwards) and thrust washer and V-belt pulley.

   Thrust washer is dished and must be located with the concave side facing the toothed pulley.

5. Check whether camshaft, crankshaft and distributor rotor marks line up on TDC mark for 1st cylinder, Fig. 208, fit toothed belt and secure crankshaft belt pulley to specified torque.

6. Using Special Tool 21–012 slacken toothed belt tensioner to enable it to become positioned against toothed belt after cranking engine twice. After cranking torque tensioner bolts as specified in Technical Data. (Hexagon bolt first, then special bolt.)

   After positioning of toothed belt crank engine in direction of rotation only.

7. Fit toothed belt guard and adjust to achieve 13 mm (0,5 in) free movement midway between alternator and fan pulleys.

8. Fit radiator, connect radiator hoses and top up with coolant.

9. Connect battery earth strap, check engine oil level and top up, if necessary.

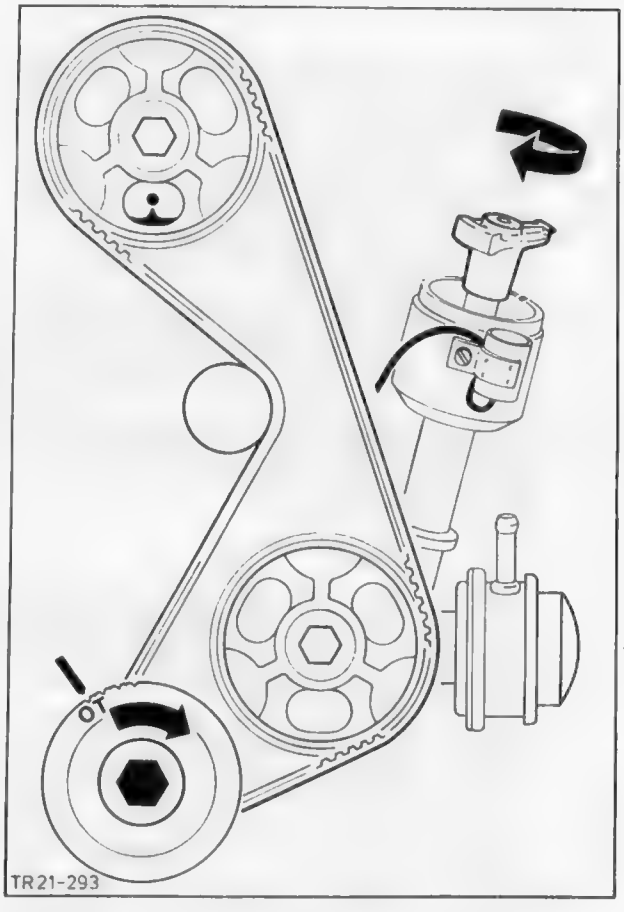


Fig. 208. No. 1 piston in TDC

21 468 4 SEAL – CRANKSHAFT REAR – REPLACE (Engine or gearbox removed)

Special Service Tools Required:

Rear oil seal remover	21–010
Crankshaft rear oil seal installer	21–011–A
'A' Engine: Clutch disc aligner	21–080
'B' Engine: Clutch disc aligner	21–044

To Remove

1. Remove clutch pressure plate (6 bolts) and clutch disc from flywheel.
2. Remove flywheel (6 bolts).
3. Withdraw oil seal, using Special Tool 21–010, Fig. 209. First completely tighten press spindle, firmly screw taper thread section into oil seal and withdraw oil seal by tightening press spindle.

   On the 'A' engine, before the oil seal can be replaced, the seal carrier must be cut out with Special Tool 21–047 (see Repair Operation No. 21 469 4)

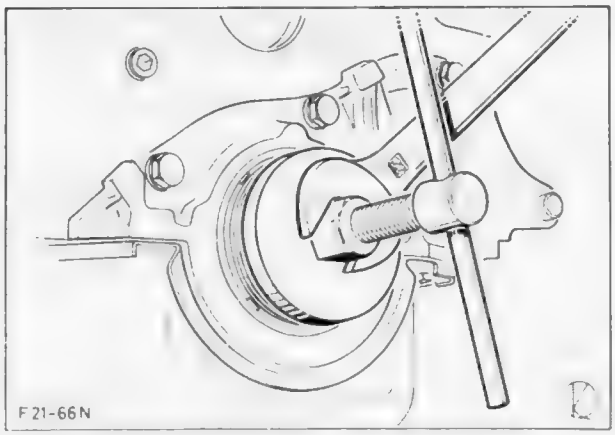


Fig. 209. Remove oil seal using Special Tool 21–010

To Install

4. Slide new oil seal onto Special Tool 21–011–A and drive in up to rear crankshaft bearing stop, Fig. 210.
5. Clean crankshaft flange and flywheel assembly. Fit flywheel and secure as specified.

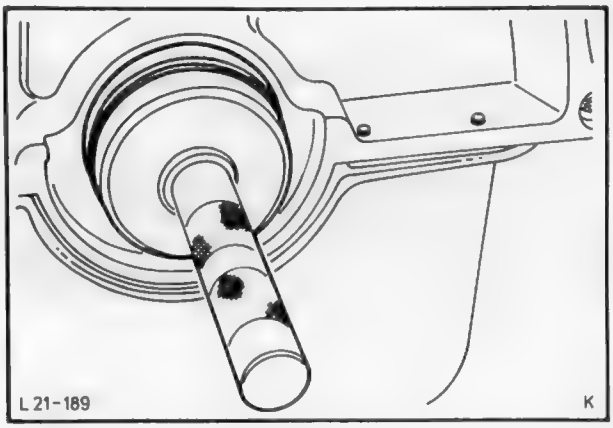


Fig. 210. Drive in oil seal, using Special Tool 21–011–A

6. Fit clutch disc and pressure plate, centering clutch disc by means of Special Tool 21–044 or 21–080, Fig. 211, and tighten bolts to prescribed torque.

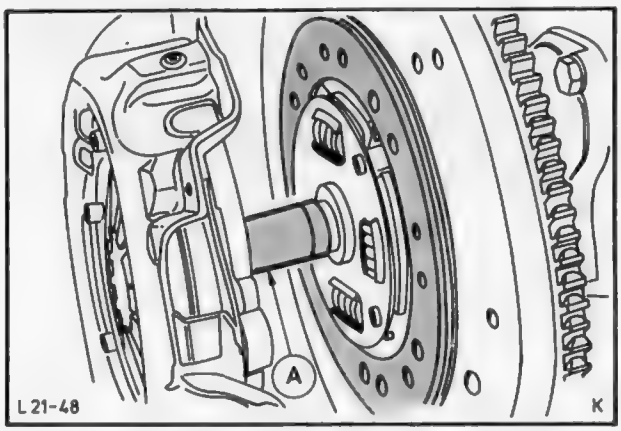


Fig. 211. Fit clutch pressure plate and clutch disc
A – Special Tool

21 469 4 SEAL ABUTMENT FLANGE – CRANKSHAFT REAR – CUT OUT (Flywheel removed)

Special Service Tool Required:

Oil seal retainer cutter	21–047

To Cut Out

1. Secure Special Tool 21–047 with knurled nut (left-hand thread) slackened, to flywheel flange by means of two bolts.
2. Rotate cutter clockwise, using open-ended spanner, and tighten knurled nut until oil seal abutment surface is cut off, Fig. 212.
3. Remove Special Tool from flywheel flange and carefully clean working area to prevent swarf from getting into engine.

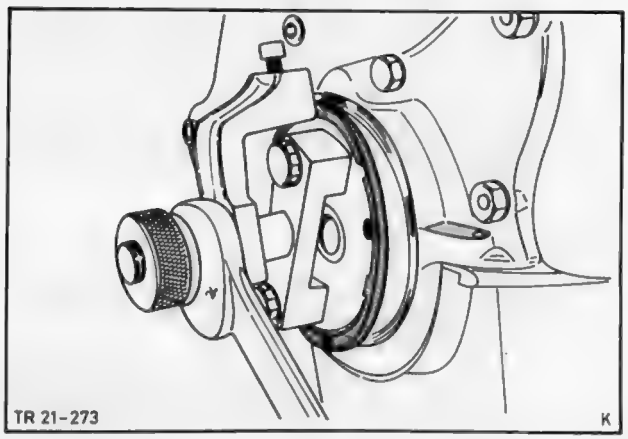


Fig. 212. Cut out oil seal carrier, using Special Tool 21–047

4. Remove oil seal, using Special Tool 21–010, as described in Operation No. 21 468, sub-operation 3.
5. Fit oil seal using Special Tool 21–011–A, as described in Operation No. 21 468 4, sub-operation 4.

21 505 5 PISTON – REPLACE (ONE) (Piston and connecting rod removed)

Special Service Tools Required: None

General

The piston and piston pin together form a unit and may only be renewed together. The piston pin bores and piston pin diameters are graded, with corresponding paint marks and they must match on another. The paint marks are on the piston crown and the edge of the pin.

If a cylinder has to be bored out by 1,0 mm it is necessary to bore out the other cylinders by the same amount. Unequal bores would cause trouble, since at 1,0 mm oversize, weight deviations of up to 10 g are possible.

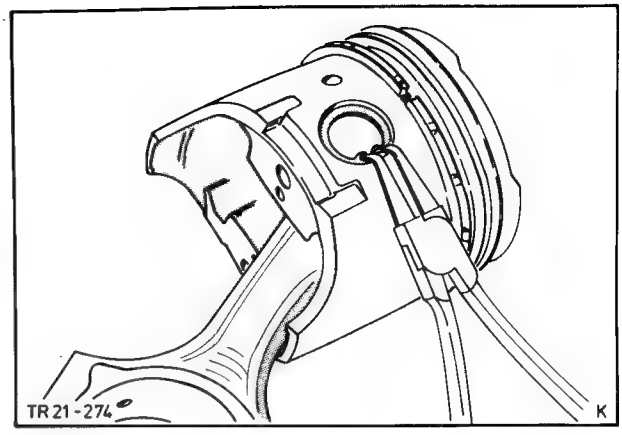


Fig. 213. Remove circlips

1. Remove circlips, Fig. 213, from piston pin bore.
2. Drive piston pin out of piston using a suitable drift, Fig. 214.

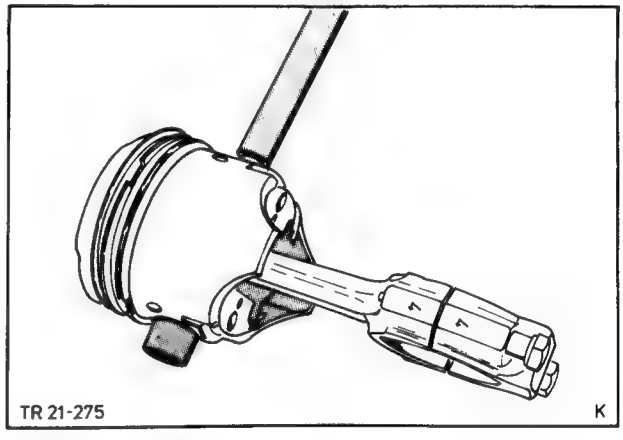


Fig. 214. Remove piston pin

To Install

3. Fit a new circlip in piston ring bore on one side of piston, Fig. 215.

   Check play in connecting rod bore (see Technical Data) before fitting piston pin.

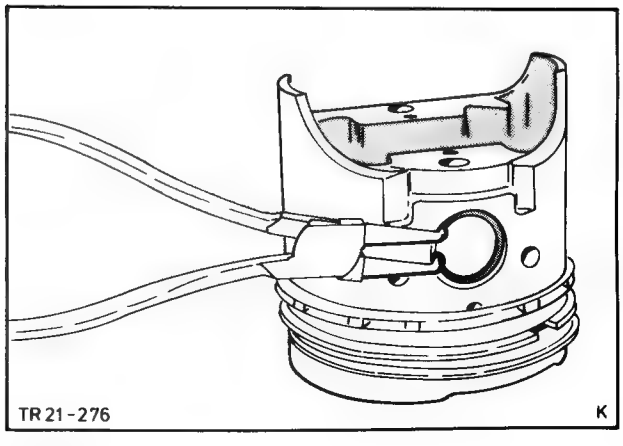


Fig. 215. Fit circlip

4. Heat piston on a hot plate (Max. 100 °C) Fig. 216.

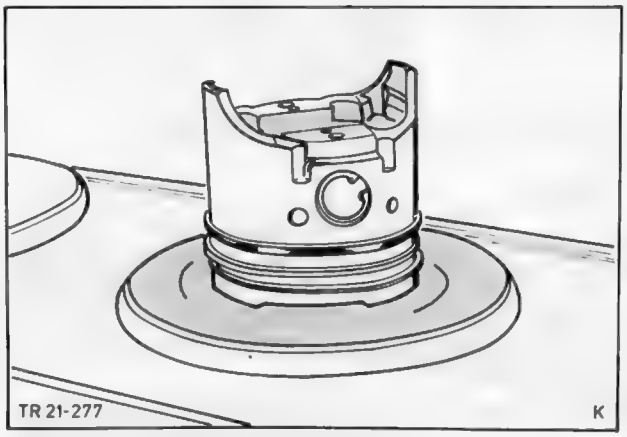


Fig. 216. Heat piston

5. Apply oil to connecting rod small-end bore and insert it into heated piston so that small-end aligns with piston pin bore.

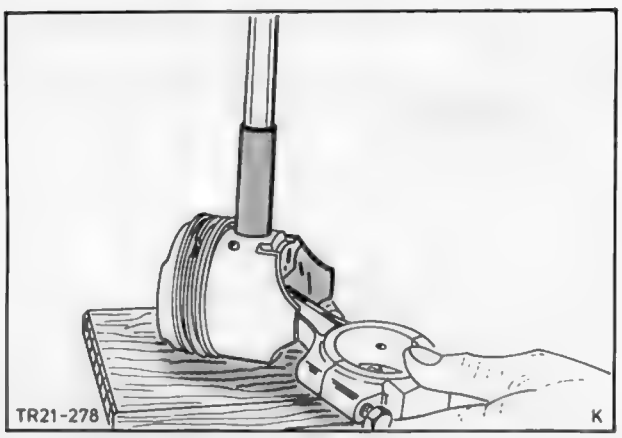


Fig. 217. Fit piston pin

6. Slide piston pin in up to first circlip fitted earlier, Fig. 217. Fit second new circlip.

During fitting the front marking on piston (arrow, notch, etc.) should point in same direction as front marking on connecting rod, Fig. 218.

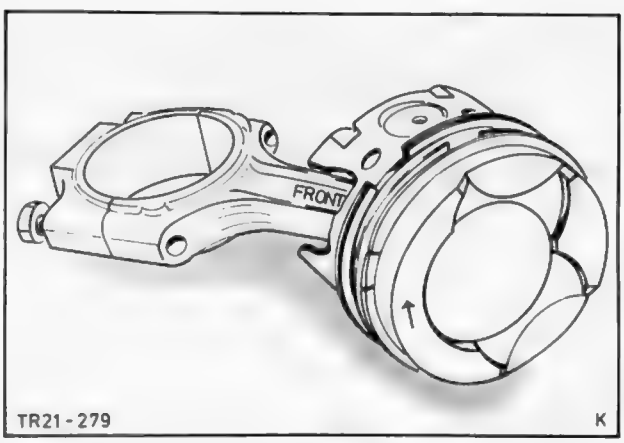


Fig. 218. Relationship of front markings

21 505 5 PISTON – REPLACE (ONE) (Piston and connecting rod removed)

Special Service Tool Required:

Piston pin installer 21–014

General

The piston and piston pin form a unit and may only be renewed together. The piston pin bores and piston-pin diameters are graded, with corresponding paint marks and they must match one another. The paint marks are on the piston crown and the edge of the pin.

It is essential for the sequence of operations using Special Tool, as described below, to be strictly adhered to because piston pin position cannot be changed after cooling of connecting rod.

If a cylinder has to be bored out by 1,0 mm, it is necessary to bore out the other cylinders by the same amount. Unequal bores would cause trouble, since at 1,0 mm oversize, weight deviations of up to 10 g are possible.

To Remove

1. Drive piston pin out of piston using a suitable drift, Fig. 219.
2. Measure connecting rod on surface plate, using feeler gauge. For maximum deviations from alignment see Fig. 220.

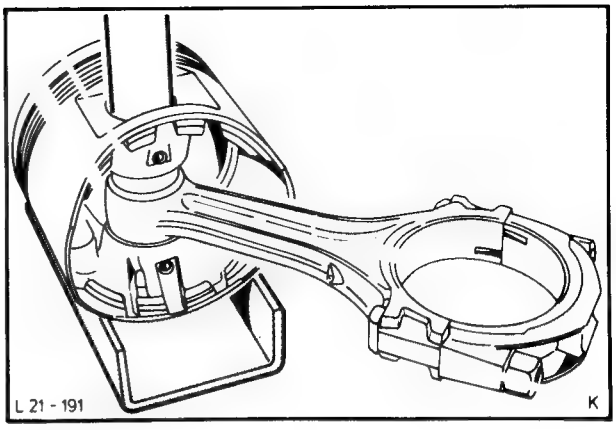


Fig. 219. Drive out piston pin, using drift

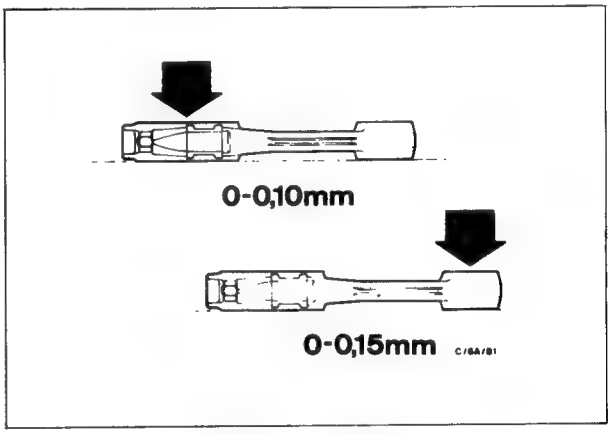


Fig. 220. Maximum deviations from alignment.
(0,10 mm = 0,004 in—0,15 mm = 0,006 in

To Install

3. Clamp Special Tool 21–014 in vice. Completely withdraw guide pin, Fig. 221.

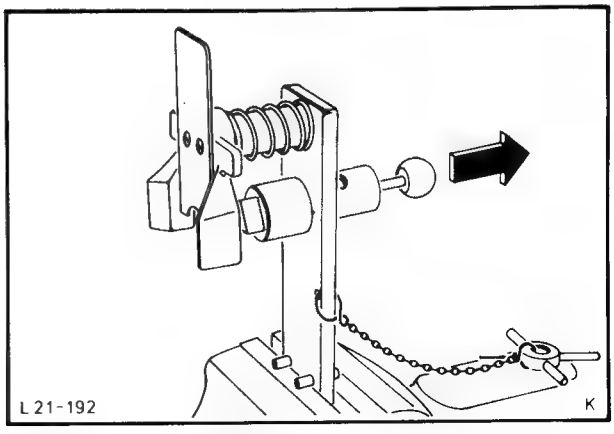


Fig. 221. Piston pin installer 21–014

4. During fitting front markings on piston and connecting rod should be positioned in relation to each other as shown in Fig. 222.

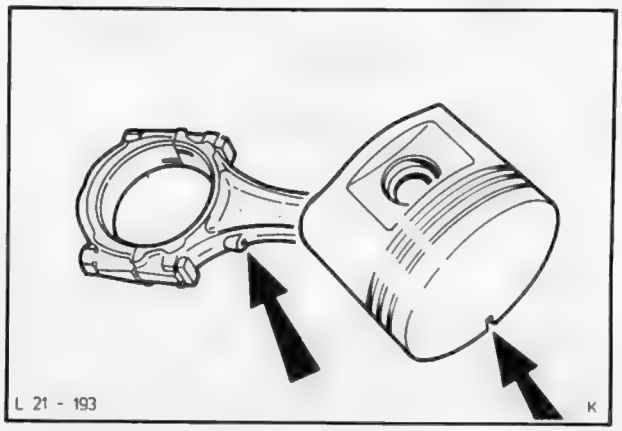


Fig. 222. Relationship of front marking and connecting rod bore

5. Clamp piston in Special Tool with front marking (arrow or notch) pointing away from Special Tool. Apply engine oil to both piston pin bores and slide guide pin through bore up to boss, Fig. 223.

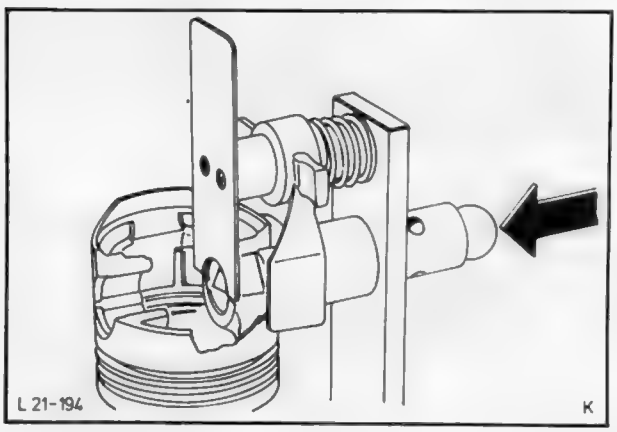


Fig. 223. Slide guide pin through bore up to boss

6. Slide piston pin up to inside edge of other piston bore. Fig. 224.

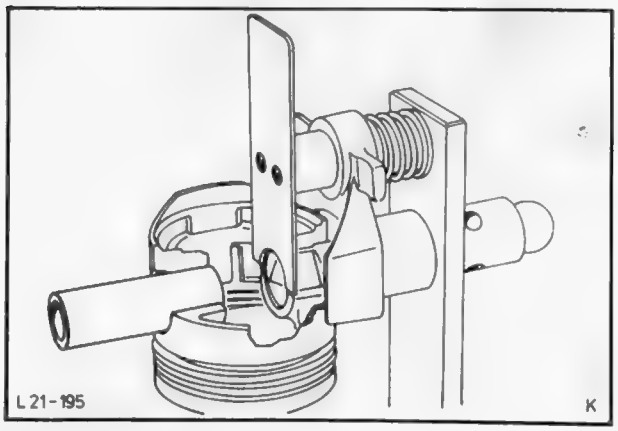


Fig. 224. Fit piston pin

7. Select stop gauge according to engine variant, Fig. 225.

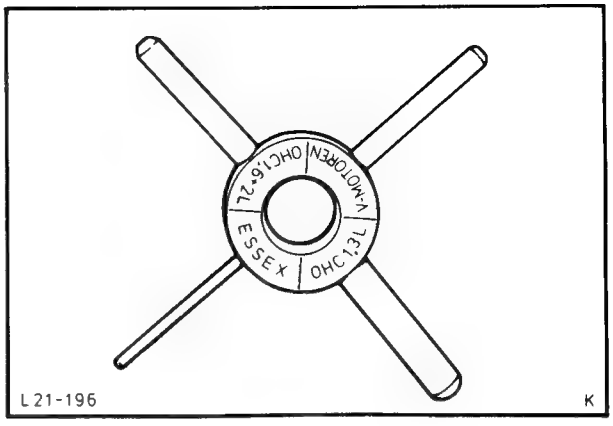


Fig. 225. Installer stop gauge

8. Insert stop gauge into Special Tool, Fig. 226.

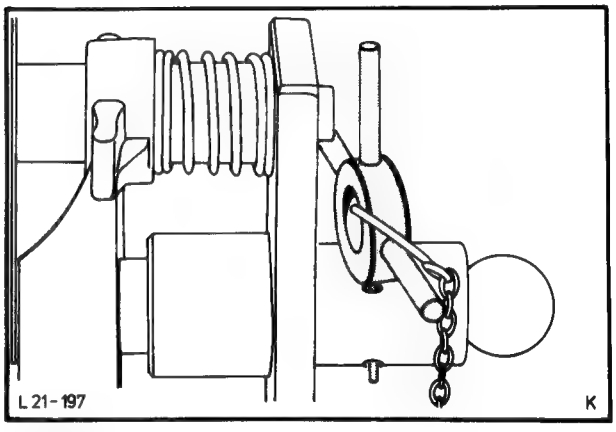


Fig. 226. Fit stop gauge

9. Heat connecting rod on a hotplate as shown in Fig. 227. Heat up piston bore to 530–570 °K (260–300 °C). To monitor temperature, mark piston bore with thermochromatic coloured pencil (Faber Castell 2815) before starting heating operation. On reaching temperature desired, colour marked on bore changes to colour of pencil cover.

Example:

If coloured pencil is green and cover black, indicated temperature of 550 °K (280 °C) is reached when green coloured mark on piston bore goes black.

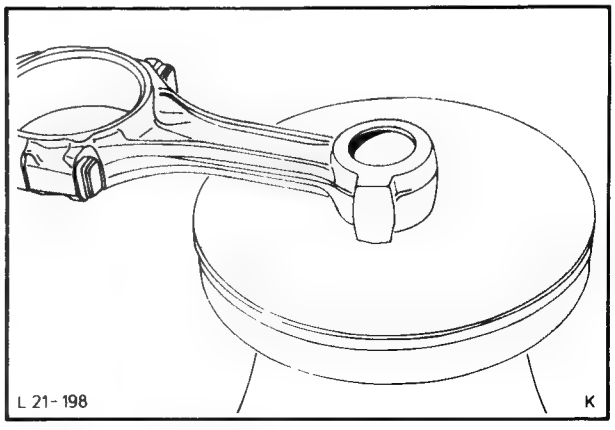


Fig. 227. Heat connecting rod

10. On reaching temperature quickly insert connecting rod into piston, then quickly slide piston pin through connecting rod up to stop, Fig. 228.

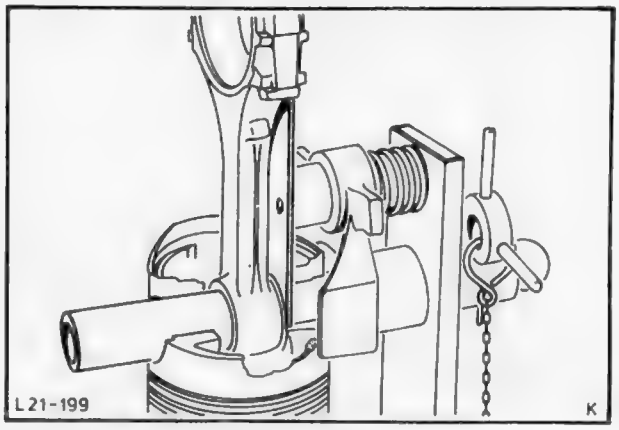


Fig. 228. Slide piston pin through bore up to stop

11. Allow connecting rod to cool slightly before removing from Special Tool.

During cooling connecting rod must abut against Special Tool, Fig. 229 and piston pin be pressed fully home.

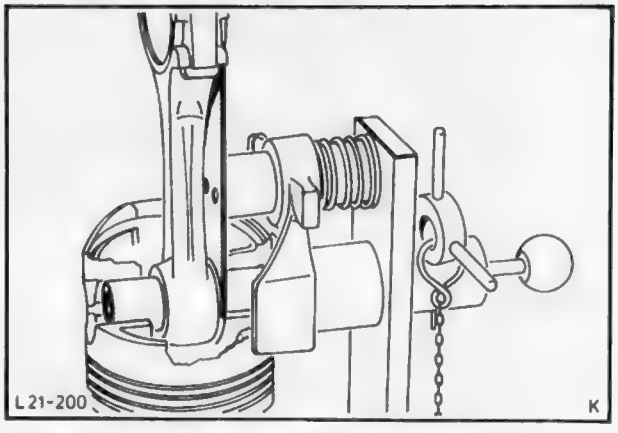


Fig. 229. Position connecting rod against Special Tool

21 553 AUXILIARY SHAFT – REMOVE AND INSTALL

Special Service Tools Required:

Oil seal installer	21–009–A
Oil pump bolt and drive belt tensioner socket	21–012

To Remove

1. Disconnect battery earth strap, slacken alternator, pivot and remove V-belt.
2. Remove toothed belt guard (3 bolts), and crankshaft pulley (1 bolt) together with thrust washer.
3. Slacken belt tensioner using Special Tool 21–012 (1 hexagon bolt, 1 special bolt), press against spring pressure and retighten, Fig. 230. Remove toothed belt.

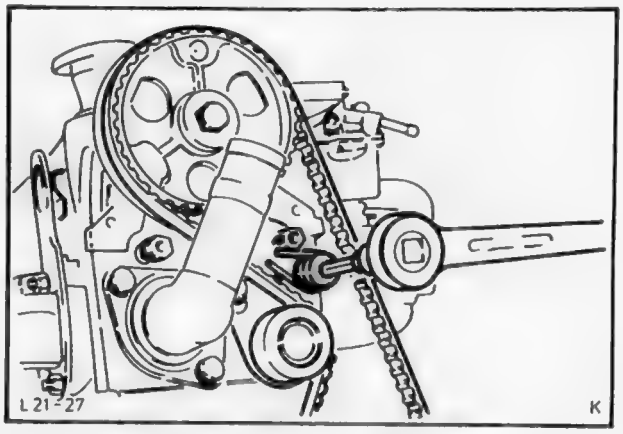


Fig. 230. Slacken belt tensioner using Special Tool 21–012

4. Remove distributor cap and remove distributor, Fig. 231. Unscrew auxiliary shaft toothed belt pulley bolt.

   Pay attention to special note in Operation 21 467 'B' engine.

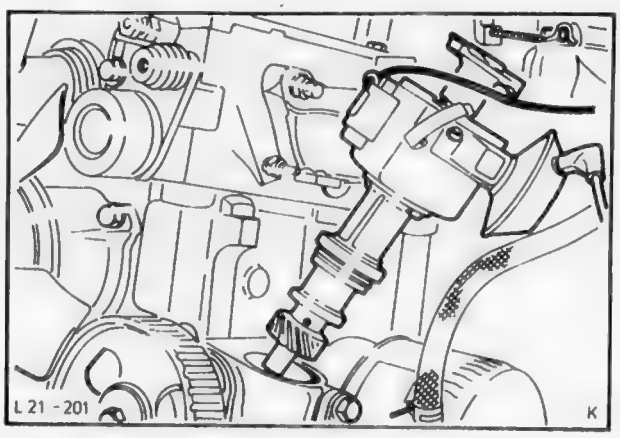


Fig. 231. Remove distributor

5. Remove fuel pump (2 bolts) and remove fuel pump tappet from cylinder block. Before doing so remove fuel lines, if necessary.
6. Remove auxiliary shaft toothed belt pulley. Remove auxiliary shaft front cover (3 bolts) thrust plate (2 bolts) and withdraw auxiliary shaft.
7. Drive oil seal out of front cover, using suitable drift, Fig. 232.

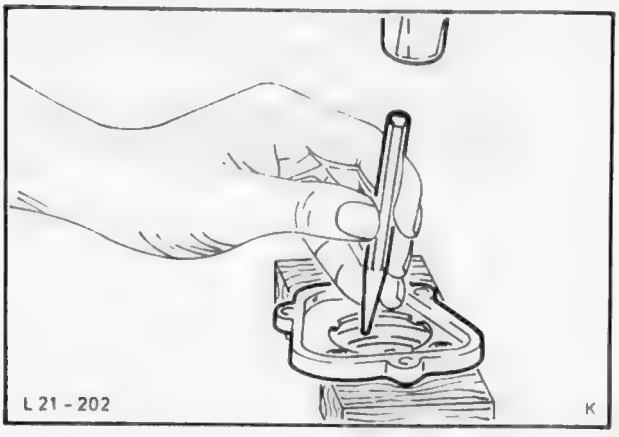


Fig. 232. Drive auxiliary shaft oil seal out of front cover, using drift

To Install

8. Fit new oil seal to front cover, ensuring oil seal is level with outer face.
9. Install auxiliary shaft and fit thrust plate, Fig. 233. Check end-float (see Technical Data) and adjust by fitting other thrust plate or auxiliary shaft, if necessary.

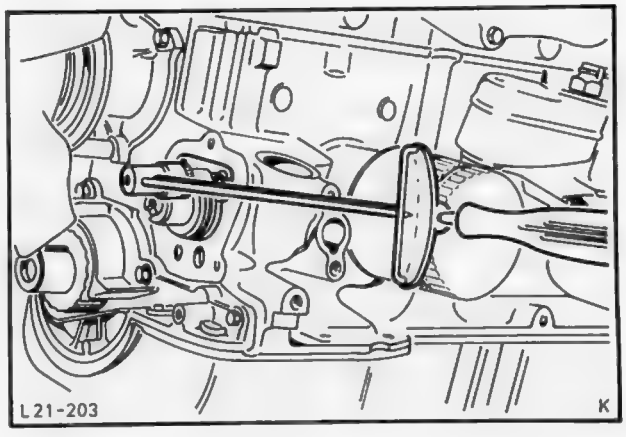


Fig. 233. Torque auxiliary shaft thrust plate bolts as specified in Technical Data

10. Slightly lubricate oil seal sealing lip. Fit auxiliary shaft front cover with new gasket **(cut off gasket not required)**, using Special Tool 21–009–A, Fig. 234, to avoid damage to sealing lip.

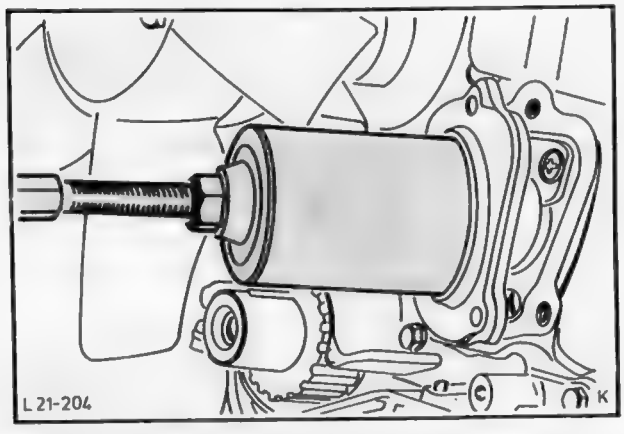


Fig. 234. Fit auxiliary shaft front cover, using Special Tool 21–009–A

11. Fit toothed belt pulley and secure with bolt. Slide fuel pump tappet into cylinder block and fit fuel pump.

Ensure auxiliary shaft gear with reinforcing ribs facing cylinder block, Fig. 235.

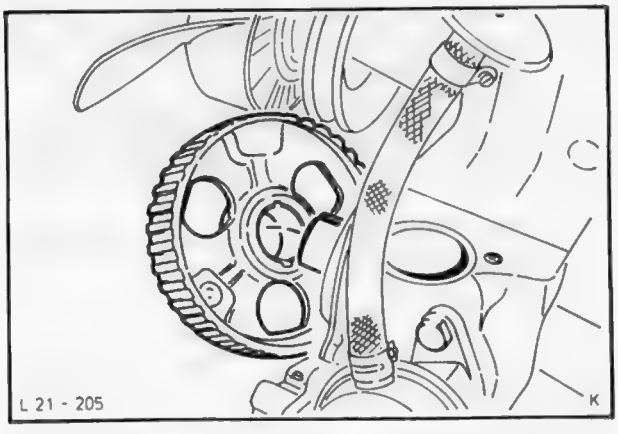


Fig. 235. Fit auxiliary shaft pulley with reinforcing ribs facing cylinder block

12. Check whether camshaft and crankshaft are aligned on No. 1 cylinder TDC mark. Fit distributor and similarly align on No. 1 cylinder mark, Fig. 236.

13. Fit toothed belt. Slacken belt tensioner so that it can become positioned against toothed belt after cranking engine twice. Torque toothed belt tensioner and auxiliary shaft pulley bolts as specified in Technical Data, hexagon bolt first, then special bolt.

    While torquing lock auxiliary shaft pulley through bolt holes.

    After positioning toothed belt crank engine in direction of rotation only.

14. Slide thrust washer and crankshaft pulley into position and torque as specified in Technical Data.

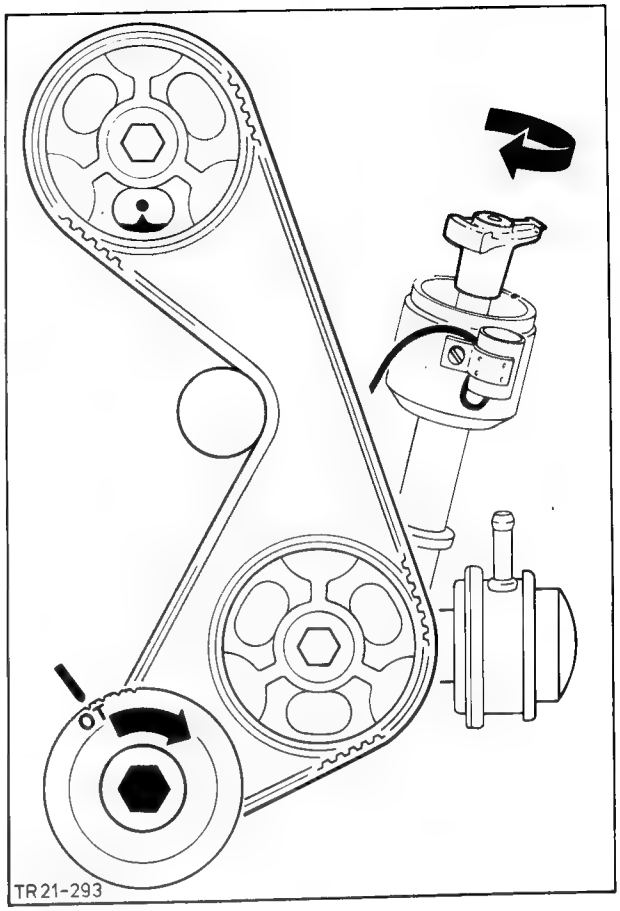


Fig. 236. No 1 cylinder piston in TDC

15. Fit toothed belt guard, Fig. 237. Position V-belt and adjust to achieve 13 mm (0,5 in) play midway between alternator and fan pulleys.

16. Fit distributor cap and connect battery earth strap.

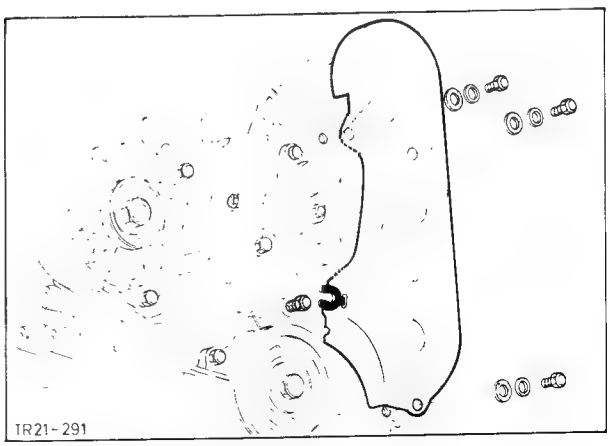


Fig. 237. Fit toothed belt guard (fan removed for clarity)

21 584 5 RING GEAR – FLYWHEEL – REPLACE (Flywheel removed)

Special Service Tools Required: None

To Remove

Centre-punch ring gear and drill two holes approximately 7 or 8 mm (0,28–0,30 in) diameter offset as illustrated, Fig. 238.

Drill must only pass through ring gear and not flywheel.

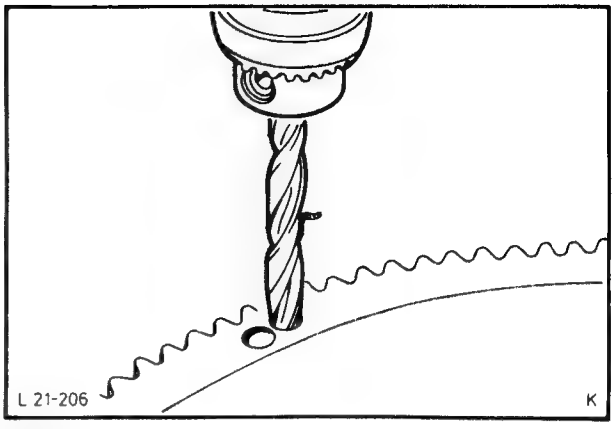


Fig. 238. Drill ring gear

2. Remove ring gear by means of light blow with a hammer, Fig. 239.

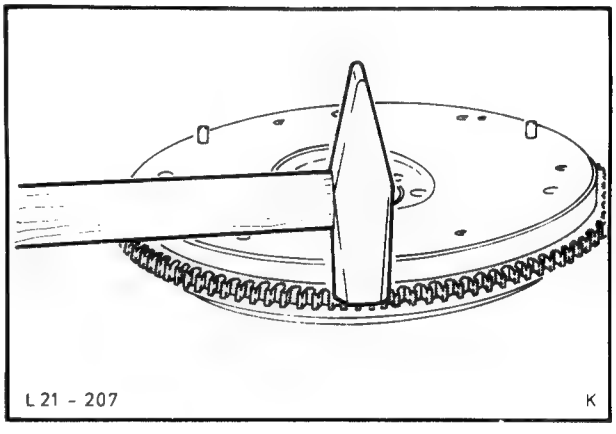


Fig. 239. Remove ring gear from flywheel

3. Place new ring gear on a plate some 2 to 3 mm (0,08–0,12 in) thick and heat up plate to 530–550 °K (260–280 °C) (500–540 °F) from below, in area of ring gear itself, using a welding torch to give uniform heating, Fig. 240.

   To monitor temperature, mark ring gear with a thermochromatic coloured pencil (Faber Castell 2815) before starting heating operation. On reaching temperature required, colour marked on ring gear changes to colour of pencil cover.

Example:

If coloured pencil is green and cover black, indicated temperature of 530–550 °K (260–280 °C) (500–540 °F) is reached when green coloured mark on ring gear goes black.

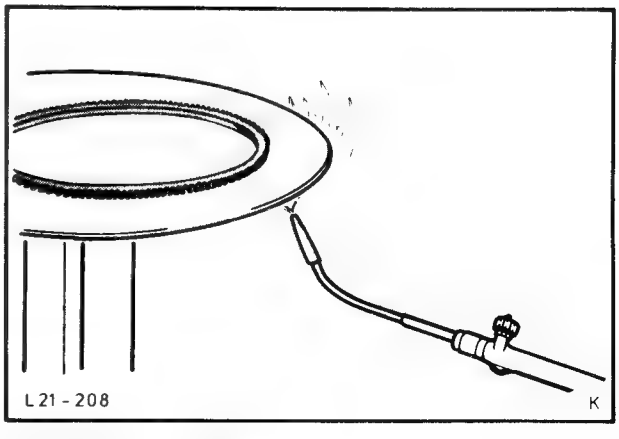


Fig. 240. Heat up ring gear

To Install

4. Slip ring gear over flywheel with tongs so that ring gear comes to rest on abutment rim. Allow to cool in this position.

   Starter ring gear is induction-hardened and loses this hardness as soon as it is heated to over 560 °K (290 °C) (550 °F).

TECHNICAL DATA			'A' Engine (OHV/I–4) 1,6 LC
General			
Engine code			L1
Firing order			1–2–4–3
Bore		mm	80,98
Stroke		mm	77,62
Cubic capacity	effective	cm^3	1598
Compression ratio			8,0:1
Pressure (compression)	at starter speed	kgf/cm^2 (lbf/in^2)	9,0–11,0 (14)
Idling speed		1/min	800±25
Engine speed	max. continuous	1/min	5800
	max. intermittent	1/min	6100
Engine power	(DIN)	kW (HP)	47 (63)
	at	1/min	5000
Torque	(DIN)	Nm (kgf.m) (lbf.ft)	110 (11,2) (81)
	at	1/min	2500
Cylinder Block			
Cast identification number			711M-6015-AA
Number of main bearings			5
Cylinder liner bore		mm	84,112–84,138
Cylinder bore diameter	standard A	mm	80,947–80,957
	B	mm	80,957–80,967
	C	mm	80,967–80,977
	D	mm	80,977–80,987
	E	mm	80,987–80,997
	F	mm	80,997–81,007
Bearing width (without thrust half rings)		mm	26,822–26,873
Main bearing shells inside diameter (fitted)			
	standard	mm	54,013–54,040
	0,254 undersize	mm	53,759–53,786
	0,508 undersize	mm	53,505–53,532
	0,762 undersize	mm	53,251–53,278
Main bearing parent bore diameter	standard	mm	57,683–57,696
	oversize	mm	58,064–58,077
Camshaft bearings in block	standard	mm	42,888–42,913
	oversize	mm	43,396–43,421
Crankshaft			
Axial play		mm	0,071– 0,276
Main bearing journal diameter	standard	mm	53,983–54,003
	0,254 undersize	mm	53,729–53,749
	0,508 undersize	mm	53,475–53,495
	0,762 undersize	mm	53,221–53,241
Main bearing shell width		mm	25,147–25,527
Play in main bearing journal shell		mm	0,010– 0,060
Big-end bearing journal diameter	standard	mm	49,195–49,215
	0,254	mm	48,941–48,961
	0,508	mm	48,687–48,707
	0,762	mm	48,433–48,453
Thrust half ring thickness	standard	mm	2,311– 2,362
	oversize	mm	2,502– 2,553

TECHNICAL DATA			'A' Engine (OHV/I–4) 1,6 LC
Camshaft			
Number of camshaft bearings			3
Drive			by chain
Camshaft retaining plate thickness		mm	4,470–4,521
Cam lift	inlet	mm	5,984
	exhaust	mm	5,894
Cam length (heel to toe)	inlet	mm	33,236
	exhaust	mm	33,460
Camshaft bearing diameter	front, centre, rear	mm	39,616–39,637
	undersize	mm	39,216–39,237
Internal bearing diameter	front, centre, rear	mm	39,662–39,675
	undersize	mm	39,662–39,713
Camshaft axial play		mm	0,064 – 0,191
Timing Chain			
Length	46 links	mm	438,15
Pistons			
Combustion chamber volume in piston		cm^3	46,786–48,171
Piston diameter	KD standard class D	mm	80,944–80,954
	E	mm	80,954–80,964
	F	mm	80,964–80,974
Piston diameter	0,064 oversize	mm	80,978–81,038
	0,38 oversize	mm	81,294–81,354
	0,76 oversize	mm	81,674–81,734
Piston to bore clearance		mm	0,023– 0,043
Piston ring gap (fitted)	top	mm	0,23 – 0,35
	centre	mm	0,23 – 2,35
	bottom	mm	0,23 – 0,35
Ring gap position	top		180 ° to scraper ring gap
	centre		90 ° to scraper ring gap
	bottom		aligned with piston pin
Piston Pins			
Piston pin length		mm	70,99 –71,37
Pin diameter	1	mm	20,623–20,625
	2	mm	20,625–20,628
	3	mm	20,628–20,630
	4	mm	20,630–20,633
Interference in piston	at 21 °C	mm	0,003– 0,008
Play in connecting rod	at 21 °C	mm	0,004– 0,10
Connecting Rods			
Bore diameter	big end	mm	52,89 –52,91
	small-end	mm	20,629–20,640
Internal diameter	standard	mm	49,221–49,256
	0,051 undersize	mm	49,170–49,204
	0,254 undersize	mm	48,967–49,001
	0,508 undersize	mm	48,713–48,747
	0,762 undersize	mm	48,459–48,495
	1,016 undersize	mm	48,205–48,239
Connecting rod journal to bearing shell clearance		mm	0,006– 0,060
Cylinder Head			
Cast marks			37
Valve seat angle		degrees	44° 30'–450
Valve seat width			1,5–2,0
Valve stem bore (inlet and exhaust)	standard	mm	7,907–7,938
	0,076 oversize	mm	7,983–8,014
	0,381 oversize	mm	8,288–8,319

TECHNICAL DATA

'A' Engine (OHV/I–4) 1,6 LC

Valves

Valve actuation			by tappet, pushrod and rocker ar
Inlet valve	opens	degrees	21° before TDC
	closes	degrees	55° after BDC
Exhaust valve	opens	degrees	70° before BDC
	closes	degrees	22° after TDC
Valve clearance	inlet	mm	0,20
	exhaust	mm	0,55
Tappet diameter		mm	13,081–13,094
Tappet clearance in block		mm	0,013– 0,058
Internal valve spring diameter		mm	20,25 –20,75
Valve spring wire diameter		mm	3,84 – 3,89
Number of turns			5,5

Inlet Valve

Valve length		mm	110,45 –111,46
Valve head diameter		mm	38,02 – 38,28
Valve stem diameter	standard	mm	7,869– 7,887
	0,381 oversize	mm	8,250– 8,268
Valve stem guide clearance		mm	0,020– 0,069
Valve lift (excluding valve clearance)		mm	9,15
Free valve spring length		mm	37,6

Exhaust Valve

Valve length		mm	111,04 –112,04
Valve head diameter		mm	31,35 – 31,60
Valve stem diameter	standard	mm	7,846– 7,864
	0,381 oversize	mm	8,227– 8,245
Valve stem guide clearance		mm	0,043–0,091
Valve lift (excluding valve clearance)		mm	9,15
Free valve spring length		mm	36,2

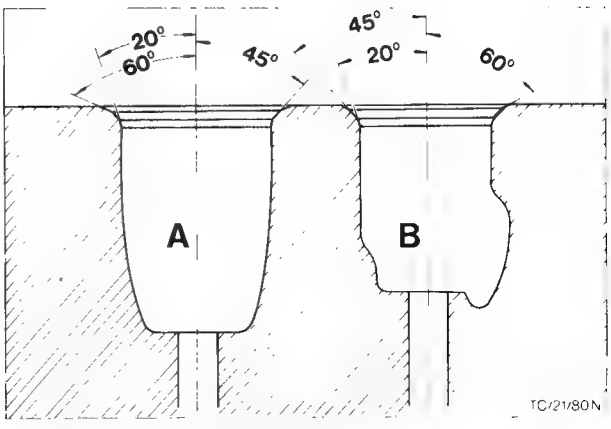


Fig. 241. Valve seat angle
A - inlet valve seat
B – exhaust valve seat

TECHNICAL DATA

'A' Engine (OHV/I–4)
1,6 LC

Engine Lubrication

Oil type			HD multigrade oil
Viscosity	from –23 °C to +32 °C		SAE 10W-30/10W-40/10W-50
	over –18 °C		SAE 15W-40/15W-50
	over –12 °C		SAE 20W-40/20W-50
	below –23 °C		SAE 5W-20/5W-30
Ford specification			SSM-2C-9001AA
Initial fill capacity	with filter	litres	3,85
Oil change	interval	km	10,000
	without filter change	litres	3,00
	with filter change	litres	3,25
Minimum oil pressure	at 750 rpm (80 °C)	kgf/cm² (lbf/in²)	0,6 (8,5)
	at 2000 rpm (80 °C)	kgf/cm² (lbf/in²)	1,5 (21,3)
Oil pressure warning light	comes on at	kgf/cm² (lbf/in²)	0,4±0,1 (5,7±1,4)
Relief valve	opens at	kgf/cm² (lbf/in²)	2,46–2,81 (35–40)
Oil pump (rotor/casing clearance)		mm	0,140–0,267
Inner/outer rotor clearance		mm	0,051–0,127
Rotor/end cover clearance		mm	0,026–0,076

Tightening Torques

			Nm	(kgf.m)	lbf.ft
Main bearings			75–82	7,5–8,2	58
Big-end bearings			41–48	4,1–4,8	33
Rear oil seal carrier			17–21	1,7–2,1	14
Flywheel			69–76	6,9–7,6	53
Clutch pressure plate			17–21	1,7–2,1	14
Chain tensioner			7–10	0,7–1,0	6
Camshaft retaining plate			4– 5	0,4–0,5	3,3
Camshaft sprocket			17–21	1,7–2,1	14
Timing cover			7–10	0,7–1,0	6
Water pump	$\frac{1}{4}$×20		7–10	0,7–1,0	6
Water pump	$^{5}/_{16}$×18		17–21	1,7–2,1	14
Crankshaft belt pulley			33–38	3,3–3,8	26
Fuel pump			16–20	1,6–2,0	13
Oil pump			18–21	1,8–2,1	14
Oil pump cover			7–10	0,7–1,0	6
Oil pump inlet pipe			18–21	1,8–2,1	14
Sump		(1)	4– 7	0,4–0,7	4
		(2)	8–11	0,8–1,1	7
Oil drain screw			27–34	2,7–3,4	22
Oil pressure switch			13–35	1,3–1,5	10
Rocker supports			35–41	3,5–4,1	28
Cylinder head		(1)	7	0,7	5
		(2)	27–40	2,7–4,0	25
		(3)	68–75	6,8–7,5	53
	after 10 to 20 min wait	(4)	88–95	8,8–9,5	67
	retighten when engine warm (15 mins at 1000 rpm)	(5)	88–95	8,8–9,5	67
	later retightening of cylinder head not needed				
Rocker cover			4– 5	0,4–0,5	39
Exhaust manifold			21–25	2,1–2,5	17
Inlet manifold			17–21	1,7–2,1	14
Thermostat housing			17–21	1,7–2,1	14
Spark plugs			25–38	2,5–3,8	25
Temperature sender unit			4,5– 7	0,45–0,7	10

TECHNICAL DATA

			'B' Engine (OHC/I–4) 1,6 LC	2,0 LC
General				
Identification code			LC	WL
Firing	order		1–3–4–2	
Bore		mm	87,67	90,82
Stroke		mm	66,00	76,95
Cubic capacity	effective	cm^3	1593	1993
	fiscal rating	cm^3	1576	1954
Compression ratio			8,2:1	8,2:1
Compression pressure at starter speed		kgf/cm^2 (lbf/in^2)	9–11 (128–156)	10–12 (129–156)
Idling speed		1/min	800±50	
Max. speed continuous		1/min	5800	
Engine power – manual transmission	(DIN)	kW (HP)	48 (65)	57 (78)
	at	1/min	4750	4500
– automatic transmission	(DIN)	kW (HP)	—	55 (75)
	at	1/min	—	4400
Torque – manual transmission	(DIN)	Nm (kgf.m) (lbf.ft)	114 (11,6) (84)	147 (15,0) (35)
	at	1/min	2800	2800
– automatic transmission	(DIN)	Nm (kgf.m) (lbf.ft)	—	145 (14,8) (107)
	at	1/min	—	2800

Cylinder Block				
Cast marks			16	20
Number of main bearings			5	
Cylinder bore diameter	standard class 1	mm	87,650–87660	90,800–90,810
	2	mm	87,660–87,670	90,810–90,820
	3	mm	87,670–87,680	90,820–90,830
	4	mm	87,680–87,690	90,830–90,840
	oversize class A	mm	88,160–88,170	91,310–91,320
	B	mm	88,170–88,180	91,320–91,330
	C	mm	88,180–88,190	91,330–91,340
	standard KD	mm	87,680–87,690	90,830–90,840
	0,5 oversize	mm	88,180–88,190	91,330–91,340
	1,0 oversize	mm	88,680–88,690	91,830–91,840
Bearing width		mm	27,17–27,22	
Main bearing shells internal diameter (fitted)				
	standard	mm	57,000–57,033	
	0,25 undersize	mm	56,750–56,788	
	0,50 undersize	mm	56,500–56,538	
	0,75 undersize	mm	56,250–56,288	
	1,00 undersize	mm	56,000–56,038	
Main bearing parent bore diameter	standard	mm	60,620–60,640	
	0,40 oversize	mm	61,020–61,040	

Crankshaft			
Axial play		mm	0,08 – 0,28
Main bearing journal diameter	standard	mm	56,97 –56,99
	0,25 undersize	mm	56,72 –56,74
	0,50 undersize	mm	56,47 –56,49
	0,75 undersize	mm	56,22 –56,24
	1,00 undersize	mm	55,97 –55,99
Thrust half ring thickness	standard	mm	2,30 – 2,35
	undersize	mm	2,50 – 2,55
Main bearing shell to journal clearance	alu	mm	0,010– 0,064
Big-end bearing journal diameter	standard	mm	51,98 –52,00
	0,25 undersize	mm	51,73 –51,75
	0,50 undersize	mm	51,48 –51,50
	0,75 undersize	mm	51,23 –51,25
	1,00 undersize	mm	50,98 –51,00

TECHNICAL DATA			'B' ENGINE (OHC/I–4) 1,6 LC	2,0 LC
Camshaft				
Number of camshaft bearings			3	
Drive			by toothed belt	
Camshaft retaining plate thickness		mm	3,98–4,01	
Cam lift (inlet and exhaust)		mm	5,9639	6,3323
Cam length (heel to toe)		mm	35,234–35,894	36,26–36,60
Camshaft bearing journal diameter	front	mm	41,99–42,01	
	centre	mm	44,61–44,63	
	rear	mm	44,99–45,01	
Bearing inner diameter	front	mm	42,035–42,055	
	centre	mm	44,655–44,675	
	rear	mm	45,035–45,055	
Camshaft axial play		mm	0,104–0,024	
Auxiliary Shaft				
Auxiliary shaft axial play		mm	0,04–0,12	
Pistons				
Piston diameter	standard 1	mm	87,615–87,625	90,765–90,775
	2	mm	87,625–87,635	90,775–90,785
	3	mm	87,635–87,645	90,785–90,795
	4	mm	87,645–87,655	90,795–90,805
	KD standard	mm	87,630–87,655	90,780–90,805
	KD 0,5 oversize	mm	88,130–88,155	91,280–91,305
	KD 1,0 oversize	mm	88,630–88,655	91,780–91,805
Piston to bore clearance		mm	0,025–0,060	
Piston ring gap (fitted)	top	mm	0,38–0,58	
	centre	mm	0,38–0,58	
	bottom	mm	0,4–1,4	
Ring gap position	top		150° from 1 side of spreader gap	
	centre		150° from opposite side of spreader gap, top mark towards piston crown	
	bottom		Spreader opposite marked front of piston, intermediate rings 25 mm either side of spreader gap	
Piston Pins				
Pin length		mm	72,0–72,8	
Pin diameter	red	mm	23,994–23,997	
	blue	mm	23,997–24,000	
	yellow	mm	24,000–24,003	
Clearance in piston		mm	0,008–0,014	
Interference in connecting rod		mm	0,018–0,039	
Connecting Rods				
Bore diameter (excl. shells)	big-end	mm	55,00–55,02	
	small end	mm	23,964–23,976	
Internal bearing diameter (fitted)	standard	mm	52,006–52,044	
	0,25 undersize	mm	51,756–51,794	
	0,50 undersize	mm	51,506–51,544	
	0,75 undersize	mm	51,256–51,294	
	1,00 undersize	mm	51,006–51,044	
Big-end journal/shell clearance	alu	mm	0,006–0,060	
	composite	mm	0,006–0,064	
Cylinder Head				
Cast marks			6	0
Combustion chamber volume		cm^3	37,5–40,5	48,6–51,6
Valve seat angle		degrees	44° 30'–45°	
Stem bore (inlet and exhaust)	standard	mm	8,063–8,088	
	0,2 oversize	mm	8,263–8,288	
	0,4 oversize	mm	8,463–8,488	
Camshaft bearing bore in head	front	mm	45,072–45,102	
	centre	mm	47,692–47,722	
	rear	mm	48,072–48,102	

TECHNICAL DATA

			'B' Engine (OHC/I–4) 1,6 LC	2,0 LC
Valves				
Valve actuation			cam follower+toothed belt	
Valve clearance	inlet	mm	0,20	
	exhaust	mm	0,25	
Inlet valve	opens		22° before TDC	24° before TDC
	closes		54° after BDC	64° after BDC
Exhaust valve	opens		64° before BDC	70° before BDC
	closes		12° after TDC	18° after TDC
Inlet Valve				
Valve length		mm	112,65–113,65	110,65–111,65
Valve head diameter		mm	41,80–42,20	
Valve stem diameter	standard	mm	8,025–8,043	
	0,2 oversize	mm	8,225–8,243	
	0,4 oversize	mm	8,425–8,443	
	0,6 oversize	mm	8,625–8,643	
	0,8 oversize	mm	8,825–8,843	
Valve stem guide clearance		mm	0,020–0,063	
Valve lift (excl. valve clearance)		mm	9,5034	10,121
Free valve spring length		mm	44,0	
Exhaust Valve				
Valve length		mm	112,05–113,05	110,05–111,05
Valve head diameter		mm	34,00–34,40	35,80–36,20
Valve stem diameter	standard	mm	7,999–8,017	
	0,2 oversize	mm	8,199–8,217	
	0,4 oversize	mm	8,399–8,417	
	0,6 oversize	mm	8,599–8,617	
	0,8 oversize	mm	8,799–8,817	
Valve stem guide clearance		mm	0,046–0,089	
Valve lift (excl. valve clearance)		mm	9,5034	10,121
Free valve spring length		mm	44,0	

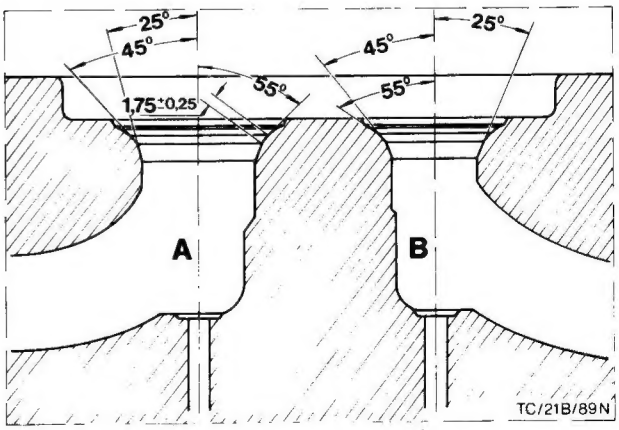


Fig. 242. Valve seat angle
A – Inlet valve seat
B – Exhaust valve seat

TECHNICAL DATA

'B' Engine (OHC/I–4)

		1,6 LC	2,0 LC
Engine Lubrication			
Oil type			HD oil
Viscosity	below −12 °C		SAE 5W-20
	below 0 °C		SAE 5W-30
	−23 °C to +32 °C		SAE 10W-30/40/50
	above −18 °C		SAE 15W-40/50
	above −12 °C		SAE 20W-40/50
Ford specification			SS-M2C-9001 AA
Initial fill capacity with filter		litres	3,75
Oil change without filter change		litres	3,25
Oil change with filter change		litres	3,75
Min. oil pressure at	750 rpm	kgf cm² (lbf/in²)	1,0 (14)
(SAE 10W-30,	2000 rpm	kgf cm² (lbf/in²)	2,5 (36)
Relief valve opens at 80 °C)	1000 rpm	kgf cm² (lbf/in²)	4,00–4,70 (57–67)
Oil pressure warning light comes on at		kgf/cm² (lbf/in²)	0,30–0,60 (4,3–8,5)
Oil pump – rotor/casing clearance		mm	0,150–0,301
– inner/outer rotor clearance		mm	0,05–0,20
Axial clearance – rotor/sealing face		mm	0,028–0,104

Tightening Torques			Nm	(kpm)	lbf.ft
Main bearings			88–102	8,8–10,2	70
Big-end bearings			41–48	4,1–4,8	33
Crankshaft belt pulley			55–60	5,5–6,0	42
Camshaft and auxiliary shaft toothed belt pulley			45–50	4,5–5,0	35
Flywheel			65–71	6,5–7,1	50
Oil pump to cylinder block			17–21	1,7–2,1	14
Oil pump cover to oil pump			9–13	0,9–1,3	8
Sump		(1)	1–2	0,1–0,2	1
		(2)	6–8	0,6–0,8	5
	after running engine 20 mins	(3)	8–10	0,8–1,0	7
Oil drain screw			21–28	2,1–2,8	18
Oil pressure switch			12–15	1,2–1,5	10
Ball pin – valve adjustment			45–50	4,5–5,0	35
Cylinder head		(1)	40–55	4,0–5,5	35
		(2)	50–70	5,0–7,0	44
	after 10 to 20 mins wait	(3)	85–95	8,5–9,5	66
Retighten after engine warm (15 mins at 1000 rpm)		(4)	90–110	9,0–11,0	74
Later retightening of cylinder head is not needed					
Rocker cover	(bolts 1–6)	(1)	5–7	0,5–0,7	4,4
	(bolts) 7+8)	(2)	2–2,5	0,2–0,25	1,7
	(bolts 9+10)	(3)	5–7	0,5–0,7	4,4
	(bolts 7+8)	(4)	5–7	0,5–0,7	4,4
Timing cover			13–17	1,3–1,7	11
Inlet manifold			17–21	1,7–2,1	14
Exhaust manifold			21–25	2,1–2,5	17
Fuel pump			17–21	1,7–2,1	14
Clutch pressure plate to flywheel			17–21	1,7–2,1	14
Water pump	(2 M8 bolts)		17–21	1,7–2,1	14
	(1 M10 bolt)		36–43	3,6–4,3	29
Water connector – thermostat housing			17–21	1,7–2,1	14
Fan to water pump flange			17–21	1,7–2,1	14
Spark plugs			20–28	2,0–2,8	18